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Project No. 802-100

January 17, 1975.

OPEN FILE

Department of Economic Development,
Government of British Columbia,
Victoria, B. C.
V8V 4R9

Attention: Mr. Peter McLoughlin,
I.P.A. Regional Studies.

Dear Sirs,

We are pleased to submit herewith our report entitled:-

"FORECAST OF DEVELOPMENTS
IN THE MINERAL SECTOR
OF THE
NORTHEAST REGION OF BRITISH COLUMBIA"

This report has been prepared by Wright Engineers Limited and H. N. Halvorson Consultants Ltd. The report covers the potential developments of the minerals and metals of the Northeast sector of the Province of British Columbia.

We appreciate your confidence in entrusting this study to us and should there be any questions we would be only too pleased to answer them.

Yours very truly,

WRIGHT ENGINEERS LIMITED

T. S. Hughes, P. Eng.
Executive Assistant.

KLMcR/tm

GEOLOGICAL BRANCH
ASSESSMENT REPORT

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FORECAST OF DEVELOPMENTS IN THE MINERAL SECTOR OF THE NORTHEAST REGION OF BRITISH COLUMBIA

by

WRIGHT ENGINEERS LIMITED

AND

H. N. HALVORSON CONSULTANTS LTD.

PROJECT NO. 802-200

JANUARY 1975

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INTRODUCTION

Wright Engineers Limited and H. N. Halvorson Consultants Ltd., were engaged to carry out a study of the known minerals potential of the Northeast Sector of British Columbia.

This study included:

a) An inventory of the known non fuel mineral occurence in the Sector.

b) An inventory of the coal reserves.

c) An inventory of the petroleum and natural gas reserves.

d) An evaluation of likely developments in the foreseeable future.

e) The social impact of these developments on the Sector.

The study is qualitative in nature and attempts to forecast general trends. Economics, where reported, are only indicative of the magnitude of the costs involved.

Not all of the Companies involved in the sector were interviewed but a sufficient cross-section of interested companies was interviewed to provide a meaningful assessment of the probable development of this sector over a twenty year period.

The conclusions are believed to be representative, but if any become crucial to government action or plans, they should be further confirmed by follow-up.

SUMMARY AND CONCLUSIONS

The mineral potential of the Northeast Region of the Province was evaluated and future developments forecast. Metals, non-metallic minerals, coal, oil and gas were considered. The potential developments are summarized in Table 1.

A. Metals and Non-Metallics

The Northeast Region has shown little potential to date for major new mineral finds and little impact can be expected over the next several years from the mineral sector in this region. The one existing mine, Consolidated Churchill Copper Mines Ltd., will probably close in the next year or so. Of the potential mines, Davis-Keays Mines Ltd. (copper), Texas Gulf's Robb Lake prospect (lead, zinc), Liard Fluorspar Mining Ltd. (fluorspar) and Silver Standard Mines Ltd. (quartz), none have a good possibility of going into production. Even if they do, the impact on the Northeast Region would be small. The total net permanent employment created (assuming Churchill Copper closes) would be 400. In addition, some 400 temporary construction jobs would be created. The impact would be in the Fort Nelson (Churchill Copper, Davis-Keays and Liard Fluorspar), Fort St. John (Robb Lake) and Chetwynd (Silver Standard) areas.

The ore found to date at Robb Lake is too low a grade to be economic. Both Churchill and Davis-Keays have low reserves and require high copper prices to be economic. Liard Fluorspar would require transportation subsidies. Only the silicon metal proposal of Silver Standard appears to have favourable economics. These however, are based on the assumption of good markets - probably an optimistic assumption. A more lenient B.C. royalty situation would obviously be of significance to Churchill and Davis-Keays but would not appear to be a serious constraint to the other properties at this time. Bill 31 has obviously proven to be a major constraint on exploration activity in this region.

B. Coal

The major developments in the Northeast in the mineral sector will be in coal. It appears that the high quality coking coals of the region will find ready markets in Ontario, Japan and perhaps the EEC.

Coalition Mining Ltd. have proposed to their parent company, Brascan Resources Ltd., that Sukunka be brought into production in stages to a rate of 600,000 tons per year by 1979. Should the coal markets develop as expected, Sukunka might be increased to a rate of 2 million tons per year by the early 1980's.

The Denison group may well bring their Quintette area property into production within the next five years at a level of two million tons per year.

Other possible producers within the next five to ten years are: Utah Mines Ltd. Carbon Creek, and Teck Corporation Bullmoose properties at similar rates of production.

If Coalition receives approval for Sukunka at 600,000 tons per year rate, by 1979 the employment at the property will be 200. Approximately 150 construction jobs will be created during the period 1975-1979. If the other developments proceed, the total employment will be:

Sukunka	600	(1982)
Babcock	600	(1980)
Bullmoose	300	(1985)
Carbon Creek	600	(1985)

The construction and peak level employment will be:

Sukunka	500	(1975-1982)
Babcock	500	(1975-1980)
Bullmoose	300	(1978-1985)
Carbon Creek	500	(1978-1985)

Before Sukunka could go to the two million tons per year rate and the Babcock, Carbon Creek and Bullmoose properties could come on stream, another bulk terminal on the B.C. coast is necessary as is rail access to each of the properties.

Coalition are considering housing personnel in Chetwynd initially. Carbon Creek might use Hudson Hope or Chetwynd as a townsite. The Dennison Babcock and Wolverine properties are too remote to consider daily transport of personnel. Flying of personnel has been considered for the more distant coal areas but it would appear that one townsite, if not two, will be required to service the Quintette and Bullmoose properties.

It would appear that in view of the very large reserves of good quality coking coal in the area, and the rising demand for this product in two firm long-term markets, most probably until the end of the century, and considering the apparently viable economics involved, every effort should be made to encourage and accelerate the putting into production of these deposits on a large multi-million tons per year scale. This would contribute significantly to the development in this sector of the province which at present has by far the lowest mineral revenue contribution.

The B.C. Royalty system as it now is applied to coal does not appear to be a serious constraint to development of new properties. However, one of the principal conditions of encouragement and incentive when commitments involving hundreds of millions of dollars are required will be the establishing of clear and well defined conditions of regulation and taxation for the industry that are not subject to change.

A fundamental constraint on development will be the availability of a stable labour force for underground mining operations. This will require not only new skilled labour, but sound training programmes.

Other areas of government assistance will be the planning and implementation of adequate port and rail facilities and service, power distribution and community developments.

C. Oil and Gas

It appears that an optimistic forecast is that crude oil production in the northeast and hence in British Columbia, can continue for only approximately 15 years and that the decline in the rate of production will have reached a critical condition within ten years.

For the next five years natural gas production can meet British Columbia's requirements and those of the El Paso contract. After that the deliverability of the fields will begin to decline as the pressure in the gas wells falls. After 1980 the only way British Columbia's requirements can be met is to phase out or cancel the El Paso contract. This contract terminates in 1988. After 1995 it appears impossible to supply British Columbia's demand.

The above situations assume that exploration will continue at acceptable levels, that the Grizzly gas field will be connected and that the unconnected wells in the Fort Nelson and Fort St. John fields will be brought into the pipeline grid.

It is expected that employment in the Fort Nelson and Taylor gas plants and fields will remain at their present level into the 1990's. A third gas plant will be built by 1980. This will employ 100 people and require 500 construction workers for the years 1978-1980. Pipeline construction over the next five years will employ 400-500 men. Exploration over the same period will employ 1,000. After 1980, exploration and pipeline construction will decline and probably stablize at about 300. Historically, exploration people have not tended to live in the exploration area. Generally they commute to their families located in major cities.

D. Sulphur

Unless the transportation of Peace River sulphur to ports is less expensive than that of sulphur from Southern Alberta, it is unlikely that major portions of the Northeast's sulphur production will be moved to markets in the next decade. Sulphuric acid for British Columbia (and probably Alberta) will come from non-ferrous metal smelters.

E. Petrochemical Production

The manufacture of petrochemicals in the Northeast is uneconomic. With pipelines already in existence, it is cheaper to move the feedstock as close to the petrochemical markets as possible.

F. Coal Gasification and Coke Manufacture

Neither of these activities can be forecast for the foreseeable future. The high grade coking coal will probably be used in the steel-making industry. Gasification of waste coal may be viable within twenty years should the production of coking coal reach 20,000,000 tons per year. Sufficient waste coal would be available to justify a gasification plant.

Steel capacity in eastern Canada may double in the next decade and the high cost of land for coking facilities and resultant pollution in high population density centres, may make it desirable to produce coke at the mines. Although it may not be viable for each mine in the area to produce coke, a central coking plant might be considered. The byproducts, such as volatiles and tars, would be valuable feedstock for a petrochemical industry.

G. Forecast Development and Employment

The probable development of the Northeast mineral sector is summarized in Table 1A by community and in Table 1B by project.

TABLE 1A

Area	Project	Townsite	Employment: Permanent	Employment: Construction
100-200 NW of Fort Nelson	Churchill Copper	80 miles W of Fort Nelson	200 (1977-1978)	(Nil)
	Davis-Keays	Churchill	200 (1977-1982)	100 (1975-1977)
	Liard Fluorspar	Fort Nelson	100 (1980-1990)	100 (1978-1980)
Chetwynd	Silver Standard	Chetwynd	150 (1978-)	100 (1976-1978)
	Sukunka	Chetwynd	600 (1982-2030)	500 (1976-1982)
	Babcock	At Mine	600 (1980-2010)	500 (1976-1980)
	Bullmoose	Chetwynd	600 (1985-)	500 (1980-1985)
Grizzly Field	Gas Plant		100 (1980-)	500 (1978-1980)
Robb Lake	120 miles NW of Fort St. John		250 (1980-)	100 (1978-1980)
Hudson Hope	Carbon Creek	At Mine (?)	600 (1985-)	500 (1980-1985)
General	Pipelines			500 (1975-1980)
	Oil and Gas Exploration			1,000 (1975-1980) 300 (1980-)

Realistically, little if any, of the mineral activity shown for the area Northwest of Fort Nelson is expected to materialize. The Robb Lake and Silver Standard projects are also doubtful.

TABLE 1 B

	LOCATION			MILLING RATE	RESERVES		Invest.		
	Mine	Mill	of Probable Townsite	TPD ORE or TPY COAL PRODUCT	Million Tons	Grade	$ Million	Employ-ment*	MAJOR CONSTRAINTS TO PRODUCTION
A) METALS									
Consolidated Churchill Copper Corp.	80 miles W. Fort Nelson	at mine	at mine	750 TPD	0.9	3.4% Cu U.	7	200 (nil)	low Cu prices, low reserves
Davis-Keays Mines Ltd.	120 miles W. Fort Nelson	at Churchill Copper	at Churchill Copper	700 TPD	1.4	3.4% Cu U.	20	200 (100)	low Cu prices, low reserves
Robb Lake	120 miles NW Fort.St.John	at mine	at mine	1,000 TPD	several	1% Pb. U. 4% Zn. U.	45	250 (100)	ore too low grade
Liard Fluorspar Mining Ltd.	200 miles NW Fort Nelson	Fort Nelson	Fort Nelson	1,000 TPD	3.5	32% CaF_2 open pit	15	100 (100)	high prod. and transp. costs
Silver Standard	20 miles W. Sukunka	Chetwynd	Chetwynd	20,000 TPY Si	300	99 +% SiO_2 open pit	45	150 (100)	market for Si metal
B) COAL									
Sukunka	35 miles SW Chetwynd	at mine	Chetwynd	600,000 TPY	100	- U.	22	200-1979 (150)	Rail line, Townsite
			Chetwynd or new Townsite	2,000,000 TPY	100	- U.	200	600-1982 (500)	Availability of labour, rail line and terminal
Denison's Babcock	80 miles SW Chetwynd	at mine	at mines or townsite	2,000,000 TPY	60	- U.	150	600-1980 (500)	rail line, terminals
Teck Bullmoose	40 miles SW Chetwynd	at mine	Chetwynd or new Townsite	2,000,000 TPY	-	- U.	150	300-1985 (300)	rail line, terminal
Utah Carbon Creek	40 miles W Hudson's Hope	at mine	at mine (?)	2,000,000 TPY	-	-	-	600-1985 (500)	quality of deposit rail access, terminal
C) OIL AND GAS									
a) Existing Gas Plant Oil Refinery	Taylor, B.C. -			0.5 billion $ft.^3$/day 2000 bbl. oil/day				75	
Gas Plant	Fort Nelson			1.1 billion $ft.^3$/day				110	
b) Future Gas Plant	Grizzly Field	not decided		1.1 billion $ft.^3$/day			100	110-1980 (500)	Reserves to be established
Exploration Activity								1,000 to 1980 then 300 after	Better incentive
Pipeline Activity	Connect Grizzly Field to main pipeline system & connect misc. wells in other 2 fields.							(400 - 500)-1980	

* Construction figures are shown in brackets

DETAILS

1. METALS AND MINERALS

A. Regional Inventory and Overview

This section deals with all mineral resources in the Region except oil, gas and coal. Gravel pits and stone quarries have not been included.

As long as the actual mineral resource inventory of an area remains unknown, the potential of an area as determined by a variety of informed opinion is indicated by the level of exploration activity. This activity is shown for B.C. by Figures 1 (1972) and 2 (1971).[1] The percentage figures refer to the number of active properties per unit area, and for purposes of this study indicate a gradation of exploration activity. without regard to expenditures?

Superimposed on these figures are the boundaries of the Northeast Region. It is evident that the level of exploration activity in the Region is lower than in the province as a whole and the high level of activity in the Churchill Copper area in 1971 did not encourage a similar degree of activity in 1972.* Evidently, the Northeast Region does not have high potential for mineral exploration.

The approach to compiling the Regional inventory has been to assemble a list of producing and prospective mines, (Table 2, Figure 3). Properties contained in this list are those which are considered to be the most likely to have socio-economic impact on the Region over the next 15-20 years.

The shortness of the list indicates that the future productive activity of this Region will be limited, and since exploration activity in an area is encouraged by previous success, the level of future exploration and development activity in the Region will also be low.

* Data for 1973 and 1974 are not yet available.

TABLE 2

PRODUCING MINES AND PROSPECTIVE PRODUCERS
IN THE NORTHEAST REGION

Company	Location	Mineralization	Grade (%)	Ore Reserves (10^6 Tons)	Milling Rate (Tons/Day)	Project Life (Years)	No. Employed
PRODUCING MINES							
Consolidated Churchill Copper Corporation	Fort Nelson	Cu	3.2	0.85	750	3	200
PROSPECTIVE PRODUCERS							
Davis-Keays Mining Co. Ltd.	Fort Nelson	Cu	3.85	1.38	700	6	200
Texas Gulf Inc.) Arrow Inter-American) Barrier Reef Resources)	Robb Lake	Zn Pb	4(?) 1(?)	4(?)	1,000	11	250
Silver Standard Mines) Hanna Mining Co.)	Sukunka	SiO_2	99.4	300	500	20+	150*
Liard Fluorspar Ltd.	Liard Crossing	CaF_2	32	3.5	1,000	10	100

* Includes both quartz mine plus silicon metal plant employment.

B. Existing Operations

Consolidated Churchill Copper Corporation is the only producing metal mine in the area. This property operates at a rate of 750 tons per day of ore and employs about 200 people. It is near Fort Nelson. Estimated operating costs are shown in Appendix A, Table 1, and a statement of estimated earnings in Appendix A, Table 2. At current copper prices, this mine is not quite breaking even. The capital cost in 1969 was $7,400,000; the current debt is $7,933,000. The mine has already closed once since coming into production and appears in imminent danger of doing so again. In any event, proven reserves can only sustain it for a few years.

Closure would result in loss of employment for 200 people. Almost all of these people live in trailers at the mine site.

The current royalty system aggravates the poor economic picture of Churchill. Removal of royalties would obviously be beneficial but at current copper prices, would probably still not put this property into a profit situation. The main problem is that this is a high cost operation and requires high copper prices. To maintain the property in operation it would be necessary to examine a system of subsidies during low copper prices. The form of subsidy has not been explored.

C. Development Opportunities Identified

The identification of development opportunities in the mineral sector consists of evaluating the potential for production of known deposits and identifying opportunities for secondary processing. The known deposits with potential for production are Liard Fluorspar, Davis-Keays, Texas Gulf and Silver Standard. Falconbridge's Sustut Copper property is located just west of the Regional boundary, but its economic thrust will be down the B.C.R. into the Central Region. Opportunities for secondary processing are limited to the proposed silicon metal plant which would accompany development of the Silica quarry. There is insufficient primary mineral processing in this region to support any other secondary processing.

In order to determine the likelihood of these developments going ahead in the future, very rough economic feasibility studies have been performed for each [9]. As no attempt was made to obtain the detailed data necessary to perform rigorous feasibility studies, the results must be considered only indicative. Nonetheless, the studies help to suggest where the problems and bottlenecks lie, and possibly, to suggest some solutions.

1. Davis-Keays Mines Ltd.

The Davis-Keays property is a high-grade, low-tonnage copper deposit located close to the producing Consolidated Churchill Copper Corporation Magnum mine. Mining would be by the expensive underground method and some underground development has already taken place.

There are two alternatives for the Davis-Keays property. A separate mill may be constructed specifically to treat the Davis-Keays ore, or the ore may be transported to the Churchill Copper mill and treated there.

The capital costs for these alternatives have been estimated by the Wright Engineers Limited Quick Capital Cost computer program, and are summarized in Appendix A, Table 3. The operating cost estimates are summarized in Appendix A, Table 1, and statements of estimated earnings are given in Appendix A, Tables 4 and 5.

At a current price of copper, (62¢ per pound) neither alternative shows the ability to recover the capital investment utilizing the proven reserve tonnage. An increase in the price of copper would help, although the Super Royalty would take an increasing portion of profit above the approximately 93¢ per pound price (calculated for 1975 conditions). Even without the B.C. Royalties, it is doubtful if the price of copper will outstrip the rising operating costs for this type of deposit in the foreseeable future.

The capital cost write-off was calculated by dividing the capital cost of the project by the proven reserve tonnage, so that this cost could be reduced by proving up more ore. However, most companies would be unwilling to write off their capital investment over more than five years for the scale of operations.

Milling at Churchill Copper appears to be the more favourable alternative, but neither proposal is likely to show a sufficiently attractive return on investment to entice the company to proceed in the next twenty years.

Because of the limited reserves (5 years), even low cost money would not make the project viable at current copper prices.

2. Texas Gulf Joint Venture - Robb Lake

In 1971 a significant lead-zinc discovery was made in the Robb Lake area at the headwaters of the Halfway River. The holders of the claims are Texas Gulf Inc., Arrow Inter-America Co., and Barrier Reef Resources Ltd. The property is still being explored and no ore reserves figures are available. It is still an encouraging prospect, but perhaps less encouraging than originally thought.

The initial indications were that there might be several million tons of ore grading perhaps 1% lead and 4% zinc. Under these circumstances, if it reaches production, it will probably be a small underground zinc mine. As with Davis-Keays, we have no information as to the mill site, the availability of water, the ease of tailings disposal, required roads and infrastructure, working capital requirements and preproduction costs.

We have assumed a hypothetical mill to process 750 tons of ore per day. The capital cost estimate is summarized in Appendix A, Table 6, the operating cost estimate in Appendix A, Table 1, and the statement of estimated earnings is given in Appendix A, Table 7.

Under the assumed conditions there is no likelihood of this property becoming a producing mine. It does not even come close to breaking even, let alone repaying the capital investment. The fact that the property is still being explored and developed indicates that the grade of ore assumed here is probably too low.

Until more detailed information comes to light, this property must be disgarded as a development opportunity for the foreseeable future.

3. Liard Fluorspar Mining Ltd.

Conwest Exploration Co. Ltd. and Jorex Mines Ltd. formed Liard Fluorspar Mining Ltd. to develop a fluorspar deposit located approximately 200 miles west of Fort Nelson at Lower Liard Crossing. In 1971 and 1972 extensive drilling was carried out and an economic evaluation was performed.

The orebody consists of a series of pods which would be mined by open pit methods. Reserves of 3,500,000 tons of ore grading 32% CaF_2 are estimated. A drilling programme of perhaps $250,000 would be necessary to firm up the reserves before production began.

Various production schemes are possible: mine and mill at site; mill at Fort Nelson; or sink/float operation at the mine and a mill at Fort Nelson. Conwest's evaluation concluded the last to be the most economic. They therefore costed a 1,000 ton per day mine, coupled with a heavy media separation plant to produce an intermediate concentrate of 52% grade at 94% recovery. This concentrate was to be trucked to Fort Nelson and milled at a rate of 750 tons per day to a 94% concentrate at 88% recovery. The capital cost estimated in 1972 was $10-14 million. The study showed that the proposal was uneconomic and so development was stopped. Based on their 1972 evaluations, Conwest concluded that a price of $110 per ton fluorspar, f.o.b. Vancouver, was required to generate a 10% return on investment. The value of fluorspar, f.o.b. Vancouver, was about $60 per ton in 1972 and is perhaps $70 per ton today for long term contracts.

The major constraint to production is the high freight costs to market.° In 1972 these were estimated to be per ton of final concentrate:

Truck - Mine to Fort Nelson, 6¢ per ton-mile for 200 miles	$24 per ton
Rail - Fort Nelson to Vancouver, 65¢ per 100 lb.	$13
Total	$37

Freight therefore represented approximately 60% of the selling price of the fluorspar product. However, the basic production costs were still too high irrespective of freight. These were estimated at $73 per ton ($110-$37) which was still about $10 per ton higher than the market value of fluorspar.

Using the available data, we have performed a rough feasibility calculation using fluorspar at $70 per ton, f.o.b. Vancouver. The operating cost estimates are summarized in Appendix A, Table 1, and the statement of estimated earnings is given in Appendix A, Table 8.

The results coincide closely with those obtained by Conwest. The freight cost for the concentrate after processing at Fort Nelson is 63% of the selling price, but even f.o.b. Fort Nelson, operating costs exceed gross revenue and there is no hope of recovering the invested capital. Subsidizing the total freight costs (intermediate and final concentrate) would cost in excess of $7,000,000 annually, which is a high price to pay to generate 100 jobs. This assumes that such a subsidy would be sufficient to encourage the company to bring the property to production, which is doubtful. Depreciating the property over a longer period (say 10 years) would be of little help. The basic problems are high operating and transportation cost. To make the property economic essentially free transportation would have to be provided in addition to operating cost subsidies in one form or another.

4. Silver Standard Mines Ltd.

Silver Standard Mines Ltd., are the holders of a large high purity quartzite deposit located just west of the continental divide, about 20 miles west of the Sukunka air strip. Although the orebody has not been completely proven as yet, the indications are that there are about 300 million tons of silica, in place. At the proposed mining rate of 500-600 tons per day, there is enough to essentially "mine forever".

The property is being jointly developed by Silver Standard and Hanna Mining Co. Ltd., with a view to providing feed for a silicon metal plant. The feed for such a plant must be of high purity (greater than 99.4% SiO_2) and in lump form, with the fines removed by screening. Because of dolomite inclusions in the orebody, selective mining must be practised to obtain the required grade. Hanna have budgeted $150,000 for a drilling programme in 1975 aimed at proving the practicality of this mining strategy. On the successful completion of this drilling programme, a feasibility study will be undertaken. If this is favourable, the property could be producing in 3 to 5 years.

Silica is converted to silicon metal in an electric furnace. The required inputs for one ton of silicon metal are:

6,300 lb.	Silica
2,265 lb.	Petroleum Coke
600 lb.	Metallurgical Coal
5,000 lb.	Hog Fuel
345 lb.	Electrodes
13,000 kwh.	Electric Energy

An ideal plant site would thus be located on a railroad and near a power transmission line. Possible locations are Prince George or Chetwynd. B.C. Hydro has expressed no preference in terms of location.

In order to approve the exploration budget for 1975, Hanna wanted assurance that the project was acceptable to the government. Silver Standard has found enthusiastic interest in all respects. The process takes a low value material and produces a high value product, while consuming a large amount of potential pollutant (hog fuel is conventionally burned in bee-hive burners, creating much air pollution). Pollution from the process is no problem; the particulates are removed from the stack gas in a bag house. Direct employment for about 150 people would be provided. To give Canadians equity in the project, Hanna agreed to give Silver Standard 50% ownership in the Company formed to run the plant. Hanna will still provide the technology, capital and marketing setup.

Our preliminary economic feasibility estimates for a 20,000 tons per year silicon metal plant ($35,000,000) are summarized in Appendix A, Table 1 (operating costs) and Appendix A, Table 9 (earnings). It was assumed that silicon metal sells for 58¢ * per pound, petroleum coke costs $50 per ton, metallurgical coal $50 per ton and power is available at 1¢ per kwh.

From this brief assessment, the project appears to warrant further study. Union Carbide has indicated that the returns on investment on a new plant would be a most unsatisfactory 5% after taxes.

Problems may be encountered in obtaining petroleum coke and in marketing. Petroleum coke in Western Canada is in demand for electrodes for the aluminum industry and more is needed for that industry. As Hanna's marketing division were the original instigators of the search for silica, Silver Standard foresees no marketing problem. This, however, would have to be very carefully researched. The most significant market is an alloying agent for aluminum. Of Canada's total consumption of 10,000 tons per year, Alcan uses 7,000 tons per year. Alcan is bringing on stream a silicon smelter in South Africa from which it will draw half its Canadian requirements. ** This reduces the Canadian market open to Silver Standard to about 7,000 tons per year. Union Carbide has a Canadian capacity of 13,000 tons per year and a West German company is constructing a 25,000 tons per year plant in Quebec. It would appear that any British Columbia producer would have to export almost all of its output. The US PNW is a larger consumer in its aluminum industry. However, Alcoa is constructing a 40,000 tons per year plant at Addy, Washington. Most of its output will be captive but about 10,000 tons per year will probably be for sale to other PNW users. Therefore the prime market for a B.C. plant would appear to be Japan. At this time Japan is approximately self sufficient in silicon.

The equipment in this plant could also be used to produce ferrosilicon (a deoxidizing agent for steel) at minor additional expense, but there is no convenient source of iron. The Peace River area is being considered for a Japanese steel plant using Brazilian iron ore, in which case a ferrosilicon plant might be attractive. These plans are highly speculative and Silver Standard are not counting on them.

In terms of impact on the Northeast Region, the gross revenue of this venture can be divided into components which will be largely respent either inside or outside the Region.

* Union Carbide's published price for 0.5% Fe silicon metal, f.o.b. works, Beauharnois, Quebec, effective October 18, 1974.

** A tariff wall on silicon imports into Canada no matter how high would not prevent Alcan from bringing in this silicon. It can recoup almost 100% of any duty through duty drawback on export of aluminum silicon alloy made with the imported silicon.

20,000 TPY SILICON METAL PRODUCTIONS

Item	Respent	
	Inside Region	Outside Region
Mining, Crushing, Ore Transportation	700,000	
Petroleum Coke		1,200,000
Metallurgical Coal	300,000	
Hog Fuel	500,000	
Electrodes		700,000
Power	2,700,000	
Labour	2,300,000	
Maintenance, Administration) Housing, Supplies Transportation)	200,000	
Silicon Transport	400,000	
Import Duty		900,000
Taxes (50% of operating profit)		3,600,000
Capital Cost Write-off ($35,000,000 over 10 years)		3,500,000
Interest(10% per year of half the capital)		1,800,000
Profits to Hanna		900,000
Profits to Silver Standard		900,000
Totals	$ 7,100,000	$13,500,000

More profits might accrue to Hanna than Silver Standard due to marketing fees and licensing of Hanna's technology, but this does not alter the impact on the Region. Based on these crude estimates, $7,000,000 annually would be contributed to the Regional economy, not counting whatever portion of the taxes would remain in the region.

Jobs for 150 people are expected to be created. Using Chetwynd's dependency ratio of 0.70, [12] the project could thus be expected to be the direct cause of a population increase of 255 people. This will be a stable, well-educated, well-paid population that will make a solid contribution to the socio-economic environment of the Region.

D. Definition and Effects of the Mineral Royalties Act and the Mineral Land Tax Act

The new Royalties structure as applicable to metallic and non-metallic minerals other than mineral fuels is briefly summarized as follows:

Commencing from January 1, 1974, the B. C. Government has instituted a two-part Royalty on designated mineral production from freehold lands in the province. (A similar "Land Tax Act", said to be equivalent in effect to the Mineral Royalties Act has been passed, to cover production from privately-owned or Crown Grant lands). By year end 1974, there were 13 designated minerals (asbestos and 12 metallics). The two-part Royalty is levied on production value, not income, and is additional to provincial mining tax and federal and provincial income tax.

Definition and Administration

The first part is a Basic Royalty consisting of, from January 1, 1975, 5% of the Net Value of a designated mineral, the Net Value being the accepted "International" selling price less normal and acceptable smelting and transportation charges.

The second part of the Royalty (commonly referred to as the Super-Royalty) is: 50% of the Gross Value less the Basic Value x 1.2; the Gross Value being the selling price less normal smelting and refining charges and the Basic Value being set by the Government on the basis of, but not necessarily equal to, the average International price paid to producers in the province over the previous five years at its first determination.

It is assumed that the Mining Tax Act will be ammended to permit deduction of Royalties from the B.C. Mining Taxable Income.

(As can be seen, the first part of the Royalty is in effect a Production Tax, resulting in a cost of production regardless of profit, and the second is a tax designed primarily to limit profits as they increase due to rapid increases in mineral price relative to costs).

All selling agreements for designated minerals must be filed by certified copy with the Administrator within 45 days of the agreement date. All agreements existing at the date of mineral designation must also be registered.

(The Act - (Bill 31) - provides for the Minister appointing an Administrator).

Within the first 15 days of each month a producer of designated minerals must file an estimate of the Gross and Net Value accompanied by payment. (This conflicts with the Regulations which only requires payment of Royalty on Gross Value actually received). A penalty of 1% per month is applied for non or late compliance. By the 15th of February of each year, the producer must make up, by payment or claim of credit, the difference between monthly payments made on estimates and the actual royalties due from actual transactions. Where the Administrator is satisfied with the correctness of returns, he will issue a Certificate for the year before April 1, of the following year.

If the Administrator considers the returns incorrect, he will demand payment of remaining amount and penalty, and the producer must pay, but retains the right of appeal.

The producer is required to keep a set of records considered adequate by the Administrator and open to inspection by him, his designate or designate of the Minister. If considered necessary, these records are subject to seizure.

Failure to pay takes the same form as a debt and becomes recoverable through the Courts.

Where there is an offence by non-payment of Royalty, the Minister may suspend or cancel operations or rights to operate. Violations are subject to fine of $1,000 per day.

Deferment of Royalty Payment may be applied for and may be granted in extendable periods of up to a year. Deferred payments accumulate interest at 9%.

The Act provides for the right of appeal on royalty payments, through the Courts.

Anyone making or acquiescing in false statements is guilty of an offence and subject to fine of $500 to $5,000. Anyone failing to cooperate in supplying requested information is guilty and subject to a daily file of $100.

Effects

The monetary effect of the Mineral Royalties Act on operating mines varies considerably with each mining operation and with the type of designated mineral or minerals produced.

The overall effect on the industry to date has been negative due to serious objections of producers.

The effect on the Northeast Secor of British Columbia appears to be minimal for producing mines as noted in Section 1.B. At this point it is difficult to determine the effect on exploration activity for the Sector. Exploration in the Province as a whole has declined and is predicted to decline further, due in part at any rate to the new legislation.

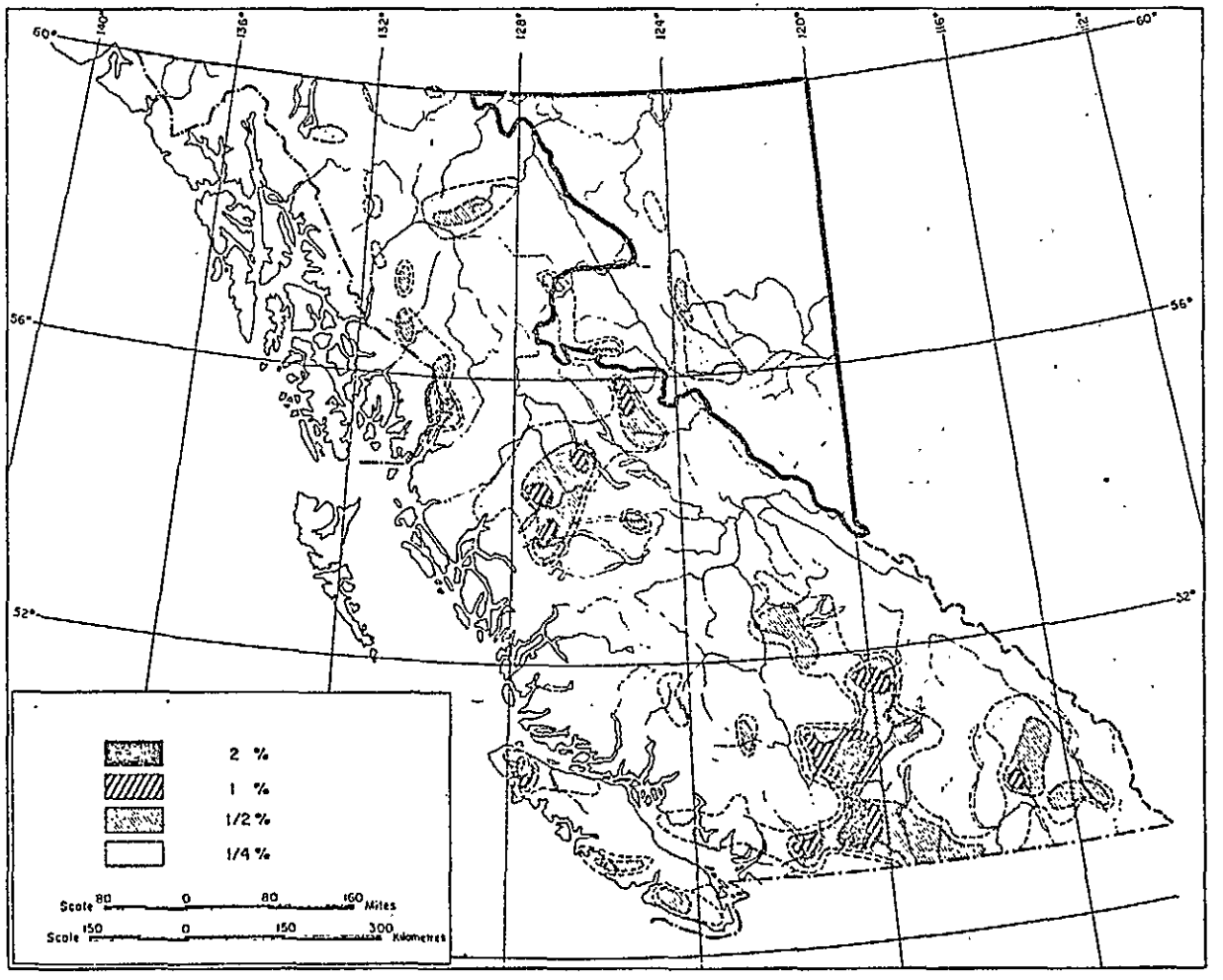

Figure 1. Distribution of mineral properties active in 1972.

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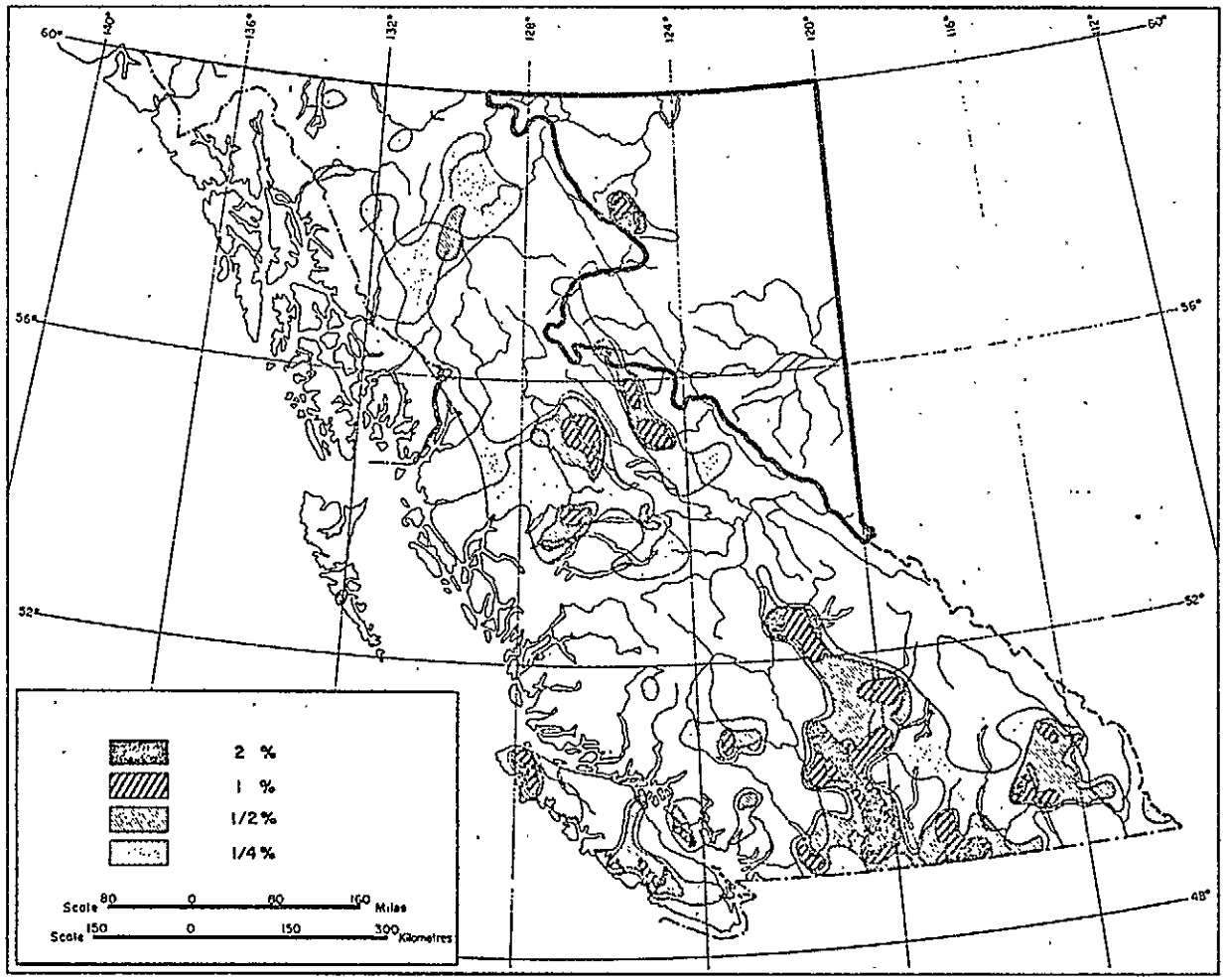
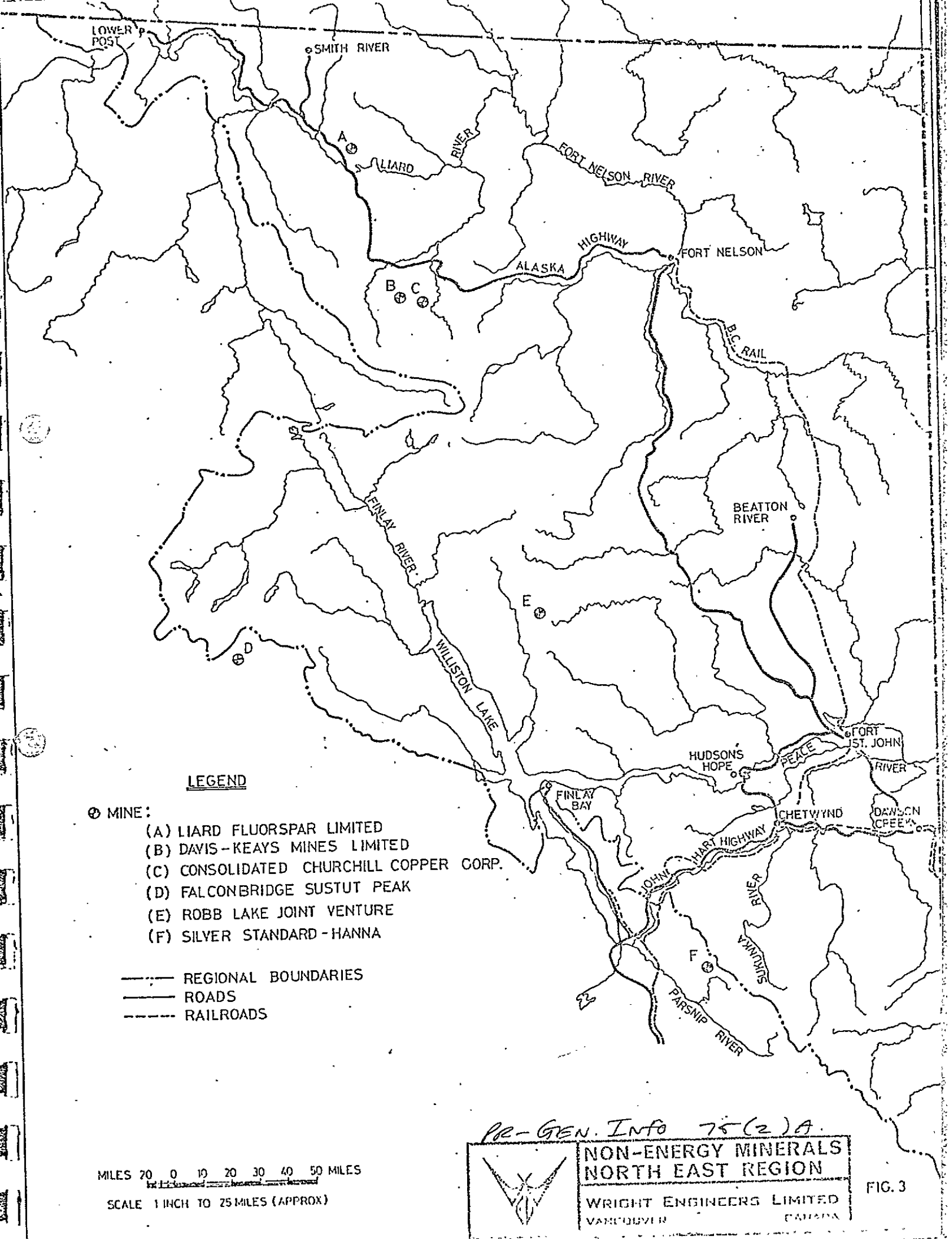


Figure 2. Distribution of mineral properties active in 1971.



PR-GEN. INFO 75(2)A.

NON-ENERGY MINERALS
NORTH EAST REGION

WRIGHT ENGINEERS LIMITED
VANCOUVER CANADA

FIG. 3

2. COAL

A. Occurrence and Reserves

1. Occurrence

Coal measures occur in the Northeast Sector of the province and are located generally on the Eastern flank of the Rocky Mountains as a continuation of the Inner Foothills Belt beginning in the East Kootenay region, extending to the north into Alberta and re-entering into British Columbia approximately 100 miles east of Prince George. These coal measures trend in a North Westerly direction from the British Columbia-Alberta border and extend for a distance of some 150 miles terminating in the area of the southern end of Williston Lake. Exploration to the north of this point has been limited to date because of difficult access, however, indications are that the coal bearing formations tend to be discontinuous from this area north.

B.A. Lataur of the Geological survey of Canada has described the Foothills belt in general in the following terms: (10)

".....characterized by numerous major folds and faults which together with the disection of the land by glacial and stream erosion permits ready deliniation of the areal extent of the coal bearing formations".

"As is to be expected in an area of such structural disturbance the seams are normally steeply inclined and, in some instances, severely contorted, thickened or thinned, cut off by faults and the coal so severely crushed as to make it extremely friable. In other instances, however, these structures have so oriented the seam with respect to the surface or so thickened the seam that excellent recovery can be made by strip mining."

"The coal, with few exceptions, is low and medium volatile bituminous in rank and invariably has a low sulphur content. Coals of excellent coking quality have been found at various localities throughout the belt but certainly not all the coal is of this quality and there is no way of predicting those areas or seams most favourable for its occurrence. Even within a given stratigraphic section containing several seams the coking quality may vary from seam to seam."

"In Northeastern British Columbia the coal is contained in the Gething Formation and the Commotion Formation. The two are separated by the non coal-bearing, marine Moosebar Formation but all three formations are equivalents of the Luscar Formation to the south."

Due to the more difficult access in general, exploration and definition of the coal occurrences in the Northeast Sector of British Columbia has lagged behind that of the areas further south, however considerable work has been done in the last few years by various companies, and this work is planned to continue for the foreseeable future.

2. Reserves

Published estimates of reserves as determined and defined by the Department of Energy Mines and Resources, Ottawa, for the Northeast Sector of British Columbia have not been updated for several years. However, as mentioned above and indicated below, considerable exploration and some development work has been carried out by various companies in the last few years all tending to indicate rapid and considerable increases in call categories.

The Department of Mines and Petroleum Resources of British Columbia are at present updating reserve figures on the basis of the latest information available. Preliminary figures, although not final at this time, are given below, together with the last official Department of Energy Mines and Resources published data of 1969:

	Thousands of Short Tons in Place			
	Measured	Indicated	Inferred	Total
Department of Energy Mines and Resources Estimates (1969) [10]	12,500	372,600	446,900	832,000
B.C. Department of Mines and Resources Estimates (1974 *[11]	569,000	795,000	3,153,000	4,517,000

* These estimates have been made using the same general parameters established by B.A. Lataur, (Department of Energy Mines and Resources) [10] but are limited to a depth of 1,500 feet.

These figures are as yet, unpublished and are intended for government use only.

It would appear from work carried out to date that the bulk of coal to be recovered from this area will be by underground methods of mining. Recent estimates by the Energy Resources Conservation Board of Alberta [12] put recovery of Mountain Region bituminous coal by underground methods at approximately 38% of in-place reserves. [13]* This then places the present best estimate of recoverable reserves in the order of 1,500 to 2,000 million short tons. Of course, recoverable reserves are dependent on as yet many undefined factors other than tonnage, such as quality, cost of plant and production, transportation and ultimately demand and price, to mention the most significant and it is recognized that many if not all of these factors still require better definition. However, all indications are that the latest figures shown are at least a reasonable working assumption.

* Coalition believe they will have a 49% recovery to clean coal at Sukunka - 70% mining recovery coupled with a 70% cleaning recovery.

B. Exploration Activity

Currently some 19 coal leases are active in the Northeast Sector of the Province. (References 14, 15, 16) The significant ones are shown on the accompanying map (Figure 4) and listed below:

Map Identification Number	Company	Property	Location	Remarks
(1)	Amax Coal Co. Ltd.		25 Miles Northwest of Hudson Hope	Formerly Ayrshine Coal Co. Ltd.
(2)	Cannibar Peak Mines	Johnson Peak	20 Miles Southwest of Hudson Hope	
(3)	Ventreal Resources Ltd.	Pink Mountain	70 Miles Northwest of Fort Nelson	
(4)	McIntyre Mines (4a)	Monkman Pass	South of Babcock	
	(4b)	Falling Creek	Southwest of Chetwynd	
(5)	Brameda Resources (5a)	Gething Creek	West of Chetwynd	
	(5b)	Sukunka	36 Miles South of Chetwynd	Optioned to Coalition
	(5c)	Bullmoose	40 Miles South of Chetwynd	Optioned to Teck
(6)	Denison Mines (6a)	Babcock Wolverine	70 Miles South of Chetwynd	
	(6b)	Saxon Belcour	140 Miles West of Grande Prairie North of Saxon property	
(7)	Bow River Resources	Gaylord Creek	20 Miles West of Hudson Hope	Formerly Hogan Mines optioned to Rainier Resources, formerly Texacal Resources
(8)	Utah Mines	Carbon Creek	40 Miles West of Hudson Hope	
(9)	Pan Ocean Co. Ltd.	Pine Pass	Near Sukunka	Optioned to Pine Pass Development Ltd.

Bulkley Valley Collieries Ltd. have over the past few years, produced in the several hundreds of tons per year for local consumption.

C. Potential Production

At this stage it appears that the most promising properties are Coalition's Sukunka and Denison's Babcock deposits. Brameda's Bullmoose property optioned to Teck Corp. and Utah's Carbon Creek deposit will probably be developed next after Sukunka and Babcock. The remaining properties are all in very early stages of evaluation.

1. Sukunka Coal

This property is leased by Brameda Resources Ltd. (47% ownership by Teck Corp.) and optioned to Coalition Mining Ltd., a Brascan Resources Ltd. subsidiary. Coalition can earn 60% interest in the property if they bring it into production by mid-1975.

Coalition plans to increase production in stages up to 600,000 TPY coal over the next five years by installing mining machines at 12 to 18 month intervals Each machine produces approximately 150,000 TPY coal and employs about 50 men. The first machine is in place now and coal at the rate of approximately 50,000 TPY is being mined. To date Coalition have spent $12 million on the property and estimate a total investment of $22 million. Financial approval for the full scale operation has yet to be made by Brascan management.

If present plans are carried forward, the production schedule should develop as follows:

Time	Production Rate	Employment
Mid 1975	150,000 TPY	50
Mid 1976	300,000	100
Start 1978	450,000	150
Mid 1979	600,000	200

The output will be moved by truck to Chetwynd and then by rail to Neptune Terminals in North Vancouver. For the first 3 years conventional trucks carrying 16 to 20 tons as per highway axle load standards will be used. For the first 30 miles from the mine a forestry road will be used, the next 6 miles will be on a government road and the last 3/4 mile on the Hart Highway. After this 3 year period, a company road will be in operation from the mine to Chetwynd and 150-200 ton trucks are being considered.

Once production reaches about 1 million TPY, a rail spur into the property would be justified. The long range plan is to use the company highway as a railbed. A rail spur from Chetwynd to the Denison Quintette (Babcock) property will probably be built as part of the development of this property should it go ahead. This spur line is expected to run east of Sukunka. Coalition would require a branch from the spur. (approximately 20 miles long).

At this stage Coalition is supplying its own power needs with diesel units. In 3-5 years time its load will justify B.C. Hydro running a line into the property. The line will follow the road from Chetwynd. The installed power requirement at a 600,000 TPY rate will be about 4,000 K.W.

The reserves at the property are 100 million tons recoverable by underground mining and 3-4 million by open pit. Production at the 600,000 TPY level will be from underground operations which will be supplemented by limited open pit operation. Some steam coal is present and eventually might be separated and sold as such. However, the coal is primarily low-medium volatile coking coal and in part at any rate, of excellent quality. It has been reported as the best undeveloped coal of this type in the world, equivalent to the best U.S. Pocahontas coal. In a large scale test in the U.K., 20% Sukunka coal blended with Welsh and Australian coals increased steel output from a blast furnace by 12% - a very significant amount.

Present plans for the first three years call for air cleaning to a 10% ash content in the coal product. The waste will be used for fill, covered with top soil and planted. After three years a washing plant will be installed. Probably the coarse coal fraction will be washed to a 5% ash content. The fine fraction may still be air cleaned to 10% ash. The final blend could be about 7.5% ash but with a moisture content (6%) low enough to meet specifications without drying. If feasible, this approach would save considerable capital and operating costs and eliminate a serious operating problem. Sukunka should therefore, require no natural gas.

The coal wastes are not expected to present a pollution problem. The raw coal contains less than 0.5% sulphur and most of this reports in the coal product. Soluble iron sulphates are not expected to be a problem even from the washing plant rejects impounding area.

Coalition has not made a final decision on whether or not to construct a townsite. At this stage they intend to house personnel in Chetwynd and bus them to Sukunka. If this proves satisfactory, all future personnel will live in Chetwynd. Should the 36 mile drive contribute to high labour turnover rates, a townsite at Sukunka will then be considered.

Should markets continue to look favourable, it is quite likely that Coalition will accelerate its production level schedule, reaching two million tons per year in six years. If this should occur, the capital expenditure is estimated to be in the order of $150 million and the number of employees is estimated at some 600. The construction would take two to three years with construction labour peaking at 400-500 men.

Construction labour for the lower production level of 600,000 tons per year is estimated at some 150 men over the next two to three years.

Coalition's present thinking is to bring Sukunka on stream at such a scale and in such a way as to minimize capital charges. This will be done at the expense of higher unit operating costs. This approach is viable if coal prices remain high. As an example, the freight costs to Chetwynd by truck will be $2.50/ton when off-highway transportation is adopted in three years. Currently, the truck costs are over $4.00 per ton. By rail, this cost would be $0.50/ton. However, a $40 million investment would be required for rail compared to $8 million for road transport.

2. Babcock - (Denison Quintette)

Denison has four coking coal properties of interest in the Northeast Sector: Babcock and Wolverine areas of the Quintette deposit; Belcourt property; Saxon property. The reserves are as follows:

		Coal in Place
Quintette:	Babcock	280 million tons
	Wolverine	N/A
Saxon		250 million tons
Belcourt		380 million tons

Denison has concentrated primarily on the Babcock deposit and in conjunction with its partner, Alco Standard Corporation, has embarked on an agreement with Mitsui Mining Co. Ltd. and Tokyo Boeki Ltd. to conduct a detailed feasibility study. All the necessary exploration work has been completed and the economic evaluation is now in progress.

Denison are unable to state if they will bring the property to production. However, if the market remains firm, it is likely that this property will be the next one after Sukunka to be brought on stream. Probably within 5 years it should be producing at 2-3 million tons per year. At this level an investment of $ 150 million is visualized and employment of 600-800. Production will be primarily from underground operation with a small quantity from open pit.

A rail spur from the Chetwynd-Dawson Creek BCR line is necessary to get this property into production. Probably, of equal importance are terminal facilities for unit train operations at a northern B.C. port.

Because of the distance from Chetwynd to Babcock (70-80 miles) or alternatively from Dawson Creek to Babcock (80 miles), it is unlikely that daily busing of personnel is possible. Rather, a townsite is required at or near Babcock. Alternatively, a system where long working periods are broken by long layover periods could be adopted. Personnel could be housed in bunkhouses at the site and join their families in say Dawson Creek for layover periods. Flying personnel from Dawson Creek to the property on a daily basis is also being considered.

3. Bullmoose Property

Teck Corporation have an option on the Brameda Resources property just south of Sukunka. Limited work has been done to date.

This property is favourably located to benefit from any infrastructure that will be established for Sukunka, just to its north or for Babcock to its south. Because of Teck's interests in Sukunka through its ownership in Brameda, Teck will probably wait to see how Sukunka fares before making a production decision.

4. Carbon Creek Deposit

Utah Mines are defining the reserves of the property. This property will probably go into production within 5-10 years. Carbon Creek will not be able to share transportation facilities as can the mines south of Chetwynd. This may or may not be a serious economic factor depending on the ease of getting rail access into the property. Carbon Creek is about 40 miles west of Hudson Hope and some 10 miles south of Williston Lake.

The only other active property in this region northwest of Chetwynd are those of Brameda (Gething Creek), Cinnibar Peak Mines (Johnson Mountain) and Bow River (Gaylord Creek), all 20-30 miles west of Hudson Hope. Much more work is required on all these properties to assess their potential.

D. Markets

Under present uncertain world economic conditions it is difficult to forecast requirements in the short term. However, the present energy crisis certainly reinforces the importance of coal for the future. Particularly is this the case with regard to coking coals which are in relatively short world supply. The immediate and most obvious significant markets for the coal of the Northeast Sector are Japan and Ontario.

Predictions of Japanese demand for metallurgical coal have been made as high as the order of 100 million tons per year by the early 1980's, of which 90% or more must be imported. Competition for this market is divided amongst Canada, Australia and U.S.A. * Canada has increased its shipments of coal to Japan from 1,300,000 tons in 1968 to some 12,000,000 tons in 1973 from the Foothills Belt in Alberta and Southern B.C. and this amount has been limited by the ability to supply. Ontario imported some 16,000,000 tons of bituminous coal from the U.S.A. in 1973 of which some 7,500,000 tons were for the metallurgical industry and the remainder for thermal power plants of Ontario Hydro. Estimates for this latter use are projected to 15,000,000 tons by 1978-79 with further increases up to 1985 (see Figure 5).

Because Ontario Hydro plants have been designed to burn bituminous coal from the eastern U.S., it is most likely that demand for this type coal will continue for some time to come. The present energy crisis indicates that more reliance will have to be placed on Western Canada coal to meet this demand. Little steam coal production however, can be visualized in the Northeast Region other than on a by-product basis to metallurgical coal production. Ontario will also likely have to depend on the west for more of its metallurgical coal need. These at present are supplied from at least partially captive sources in the eastern U.S. As coal requirements increase within the United States the export of coal can be expected to be curtailed. The Ontario demand will be increasingly dependent on Western coking coal and this sector would be in a good position to supply a considerable portion of this market.

Technological change, presently under study and experiment both in Japan and Ontario may affect the particular need for the low and medium volatile bituminous coal, but this change is not expected to have any significant effect for some considerable period of time due to necessary changes required in existing plant and methods.

Coking coal is also in demand in other world markets with Latin America, if not Europe as well, as potential customers.

Demand trends of course are reflected by the price change for low and medium volatile coal. This trend is indicated on Figure 6.

In summary, the general demand picture and consequent price structure of the near future all indicate viable conditions for the production of good quality coking coal from the Northeast Sector of B.C. in spite of expected high production and transportation costs.

* In 1973 the U.S. supplied approximately 40%, Australia 40% and Canada 20% of Japanese requirements.

E. Problems to be Resolved

Two of the proposed operations have defined sufficient reserves in terms of tonnage and quality in order to proceed with production plans. Problems still requiring further definition would appear to be the following:

1. Mining

Futher work on ground conditions for under ground mining is required in order to determine the best mining methods and equipment to be used, as well as better definition of costs.

2. Processing

Determination of best processing equipment combinations and flow sheet in order to meet varying possible specifications of coal buyers.

3. Access

Road and possible rail access to the various sights still require study, although distances and terrain problems to existing highways and rail lines do not appear to be excessive.

4. Housing

The use of existing communities such as Chetwynd and Dawson Creek have been considered as well as the establishment of housing facilities in whole or in part closer to the proposed mine sites. The use of established communities would involve the need for busing (35 miles Chetwynd to Sukunka) or even flying (70 miles Dawson Creek to Quintette). These would appear to be only temporary or interim solutions to the problem.

Long term solution for the potential size and performance of operations, together with consideration of the serious problem of labour turnover, will almost certainly dictate the establishment of new modern communities closer to the operation.

5. Personnel

One of the most challenging problems will undoubtedly be the obtaining of an adequate and relatively stable labour force for underground operations. This has already been felt in the new mines of Alberta and Southern B.C. Certainly a considerable number of coal miners will have to be brought in and concentrated training programs carried out in order to meet the need. The staging of production over a number of years up to a design output may well be necessary due to this problem alone. Sources of labour may include Eastern Canada as well as Eastern Europe.

Construction labour may have to compete with the proposed Site No. 1 hydro project in the area and wage differentials between construction and production should be minimized. Present Sukunka wages are $5.50 per hour, compared to Hydro Construction wages of $8.00 per hour. Permanent employment should, of course, offer indirect benefits over construction labour, such as, better fringe benefits, cheaper and better housing, community life, to mention a few, besides permanency.

6. Electric Power

It would appear that an overall scheme for power distribution to the several possible mine sites should be studied and developed in the near future. Power requirements are in the order of 3,000/4,000 Kw of installed power per million tons of coal mined and processed per year.

7. Reclamation

A well defined program of waste disposal and land reclamation must be established as an essential part of costing of operations.

8. Transport

One of the fundamentals of economic production of coal from the area is a sound system for long distance transportation of the salable product. Successful unit train operation has now been established for the movement of coal from Southern B.C. to the Pacific Coast. Both Canadian Pacific and National Railways are actively committed to a unit train system to move coal from Alberta and B.C. to Ontario via rail to a large bulk terminal at Thunder Bay, and from there by Laker to Lake Erie ports. This system is due to go into operation by 1976/77. (19) Rates are in the process of being established in order to encourage movement of Western coal via this system (see Figure 7).

Consideration has already been given to the establishment of a bulk terminal for coal in the general area of Prince Rupert and this would appear to make sense. Existing terminals at Vancouver and Roberts Bank as well as the rail lines from Alberta and Southern B.C. to these points are already reaching their limit of capacity. It would appear that each of four main general areas of possible production may be most conveniently connected to existing railroads by separate spur lines.

Representative freight rates for long-distance movement of coal are presently as follows:

Sparwood-Roberts Bank	$ 5.52/ton (Unit train)	CPR
Elkview - Thunder Bay	$11.00/ton (85 car std train)	CPR
Winniaty- Thunder Bay	$11.73/ton (85 car std train)	CNR
Chetwynd- Vancouver	$ 9.00/ton	BCR

For the longer term, pipeline transportation of coal should be considered.

9. General Study

Other areas of possible investigation are as follows:

- Hydraulic Mining
- Storage of Rejects
- Utilization of Rejects
- Market Research
- Coal Drying
- Coal Gasification

F. Impact on Existing Conditions

As mentioned above, indications are that exploratory activity will continue at an increasing rate over the next few years, with the possibility of construction of some three to four mines and treatment plants within the next five to ten years. Employment in the exploration stage continues to involve some 50 to 100 people in the area with as many as half being drawn locally.

The construction phase of mines and plants if implemented is expected to employ up to 1,000 or more people over the next five to ten years and the production stage to employ as many as 2000. The existing communities in the area will be stretched to capacity in terms of accommodation and services. These include Dawson Creek (Pop. 1971 - 12,000), Fort St. John (Pop. 9500 - 1971), and Chetwynd (Pop. 1971 - 1400). The Prince George-Peace River Electoral District in 1971 had a population of 108,000.

Once production commences, the effect will be wider, reaching transportation points such as Prince George (Pop. 1971 - 39,500) and Prince Rupert (Pop. 1971 - 15,750), if a Port and Terminal are established in the area of the latter.

G. Economics

Operating costs for the production of coal in the area as a whole are not yet definable with any reasonable degree of confidence, however, Coalition has estimated the following 1974 costs for a 600,000 tons per year underground operation which appear to be reasonable:

Direct Operating Costs/short ton		$16.00
Transportation to Vancouver*		
- Truck to Chetwynd	$4.40	
- Rail loading	$1.00	
- Rail Chetwynd Vancouver	$9.00	
- Handling at Port	$1.10	
		$15.50
Royalty		$ 1.65
Total		$33.15
January 1975 price per ton (selected Southern B.C. coal for export to Japan)		$36.50

* Transportation costs by Unit Train to a port in Prince Rupert area should be significantly lower.

It is expected that financing for the coal development projects in the $100 million dollar or more range, will likely be obtained from Equity (of one or a consortium of companies, perhaps including government), and the open market (national and or international financing institutions).

H. Major Constraints

1. Sukunka

Other than the straight economic viability of the project, the major constraint Coalition see with the Sukunka development on the scale presently contemplated is labour availability and turnover rates. Rail transportation and existing port facilities are adequate as are its immediate housing facilities in Chetwynd.

Before Sukunka can be expanded much beyond 600,000 tons per year, rail access and bulk handling port facilities on the North Coast are required.

2. Babcock and Bullmoose

The major constraints to these developments are rail access and new bulk handling facilities on the coast. At the scale envisaged, truck transportation to rail would not be viable compared to rail. Existing port facilities are reportedly inadequate.

In the case of Babcock, housing will be a constraint. It is too distant from existing townsites to permit daily busing.

3. Royalties

The base royalty on the coal does not appear to be as serious a concern to coal operators as it is to metal miners. The price of copper, for example, is beyond the control of the individual copper mining company. Coal on the other hand is negotiated on an individual contract basis and the royalty can be passed on as an operating cost to the customer. Should coal be designated for a super royalty, based on the selling price of coal, and if this royalty could not be passed on to the customer because of its magnitude, this could be a serious handicap to NE producers who have higher operating and transportation costs than might SE producers. Superior quality and subsequent better prices might compensate however. A very detailed study would be required to assess the true effect.

4. Coal Act - 1974 (Bill 92)

The new Coal Act sets out the conditions for the exploration and production of coal.

The Act appears to be somewhat arbitrary tending to create uncertainty because of its discretionary powers in respect of the issuing of Permits, Leases and Licences, and the amount of Royalty, which at present is not significant.

The Act also provides for the designation at any time of Coal Land Reserves, removing these from possible production.

The Act also negates the right of appeal beyond the Lieutenant Governor in Council with respect to the Minister's decisions.

I. Required Government Action

It would appear, that in view of the very large reserves of good quality coking coal in the area, and the rising demand for this product in two firm long term markets, most probably until the end of the century, and considering the apparently viable economics involved under the right conditions, every effort should be made to encourage and accelerate the putting into production of these deposits on a large multi million tons per year scale. This would contribute significantly to the development in this sector of the province, which at present has by far the lowest mineral revenue contribution.

One of the principle conditions of encouragement and incentive will be the establishing of clear and well defined conditions of regulation and taxation for industry in this field, involving the commitment of hundreds of millions of dollars for development.

A fundamental constraint on development will be the availability of a stable labour force for underground mining operations. This will require not only new skilled labour, but sound training programmes.

Other areas of government assistance will be the planning and implementation of adequate port and rail facilities and services, power distribution and community developments.

Many of the fundamental problems regarding mining, processing and transportation have already been tackled through the efforts of various groups and companies over the last few years in bringing into successful production the deposits of Southern B.C. and the Inner Foothills of Alberta just to the south. Undoubtedly much of this valuable experience can be applied to the extraction treatment and movement of coal from the Northeast Sector of B.C.

J. Coke Production

Coke production in the Northeast Sector cannot be contemplated in the next five year period. However, within twenty years annual production of coal may reach 25 million tons, of which a considerable portion would be consumed within Canada. Although the degradation involved in shipping coke may be a serious constraint, certain benefits would accrue to the province if coke production was undertaken in conjunction with a coal gasification plant in the vicinity of the operating mines. The coke gas could be reformed to produce methane to supplement the natural gas supply and the tars produced would be available for use in a petrochemical industry.

K. Coal Gasification

Consideration in future should be given to the construction of a coal gasification plant for the area.

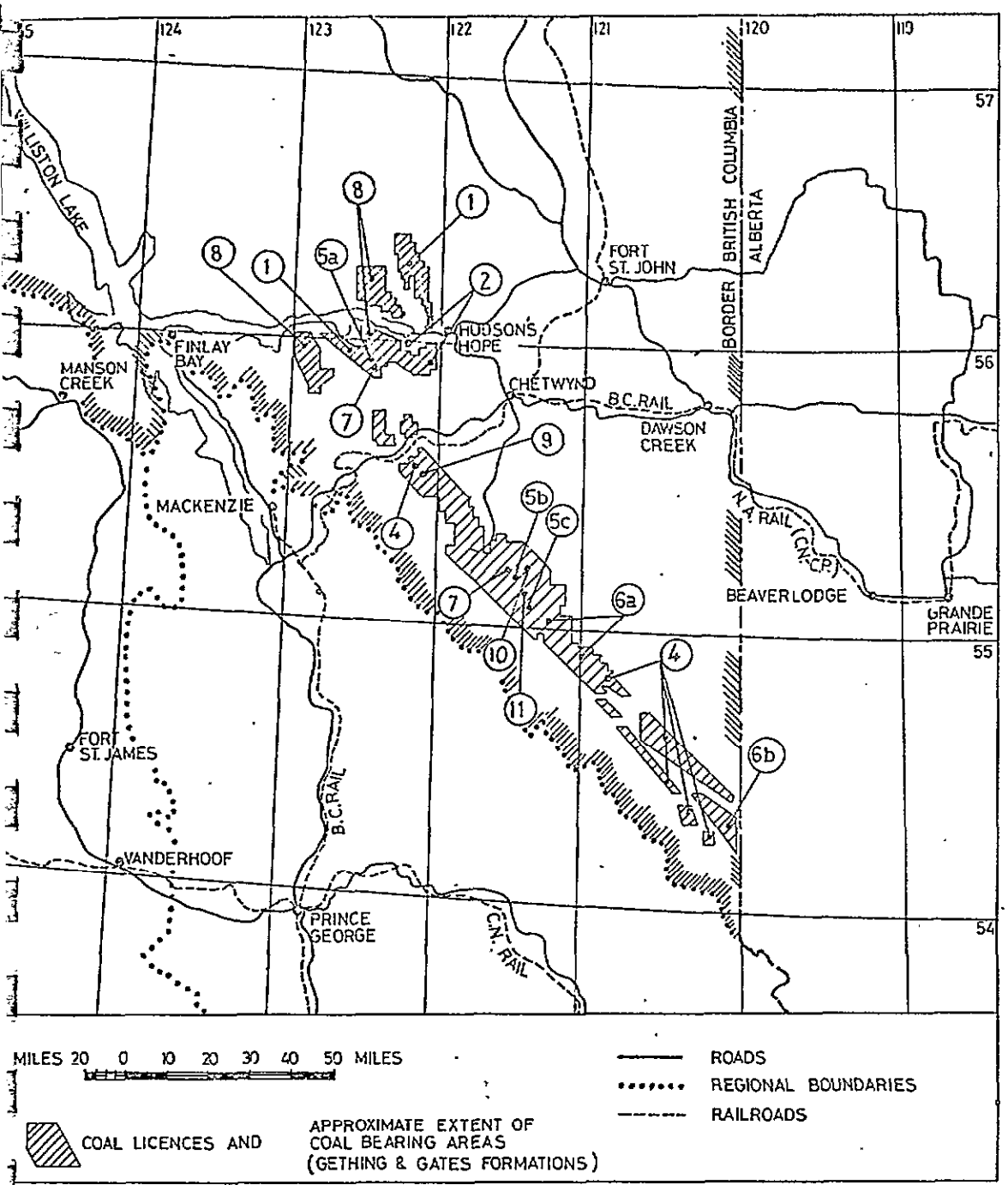
Although economic plants of this type are still in the pre-production stage, it is felt that they will become a reality in the near future.

Studies to date indicate minimum economic size to be in the order of 250 million SCF per day of methanated gas (approximately 1,000 BTU) requiring in the order of 7-8 million tons of thermal coal per year.

Subject to a better definition of actual coal types in the area, it is estimated that some 25% of coal mined will be recoverable for thermal use. Some will be recovered in effect as a by-product from metallurgical coal mining and processing and some can probably be mined directly as thermal coal.

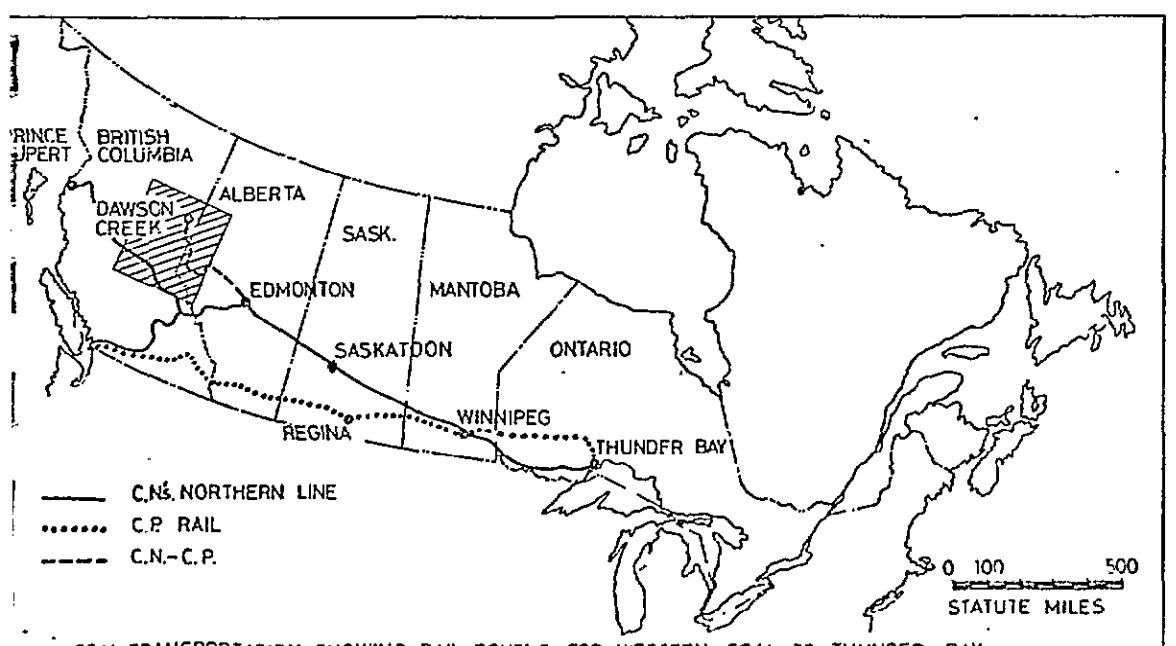
Under these conditions a gasification plant could be considered when metallurgical coal production reached a level of some 25 to 30 million tons per year. This could take place within the next 20 years. The cost of such a plant with its supplying mining facilities, is estimated to be in the order of $600 million (1974).

The methanated gas produced could be put directly into the existing natural gas transmission and distribution system.



1. AMAX COAL CO. INC.
2. CINNABAR PEAK MINES LTD.
3. VENTREAL RESOURCES LTD. (70 MILES N.W. OF FT. NELSON)
4. McINTYRE PORCUPINE MINES LTD.
   - 4a MONKMAN PASS
   - 4b FALLING CREEK
5. BRAMEDA RESOURCES LTD.
   - 5a GETHING CREEK
   - 5b SUKUNKA (OPTION COALITION)
   - 5c BULLMOOSE (OPTION TECK CORP.)
6. DENNISON MINES LTD.
   - 6a QUINTETTE (BABCOCK, WOLVERINE)
   - 6b SAXON (SAXON, BELCOURT)
7. BOW RIVER RESOURCES
8. UTAH MINES LTD.
9. PAN OCEAN OIL LTD.
10. MASTER EXPLORATIONS LTD.
11. NATIONAL TRUST CO. LTD.

FIG. 4



COAL TRANSPORTATION SHOWING RAIL ROUTES FOR WESTERN COAL TO THUNDER BAY

FIG. 7

COKING COAL DEMAND
JAPAN & ONTARIO

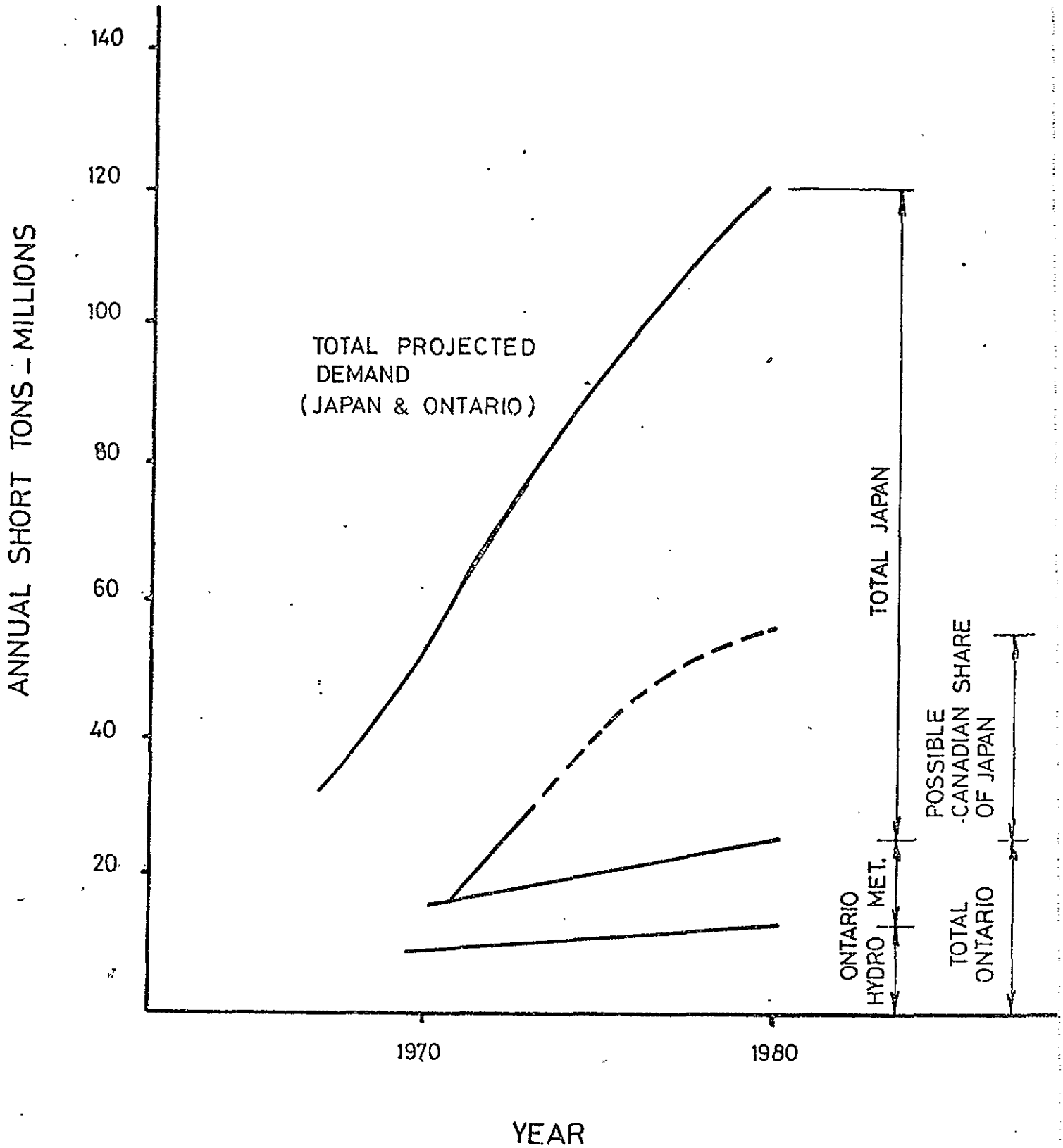


FIG. 5

COKING COAL PRICE FOR EXPORT TO JAPAN
(F.O.B. B.C. PORT)

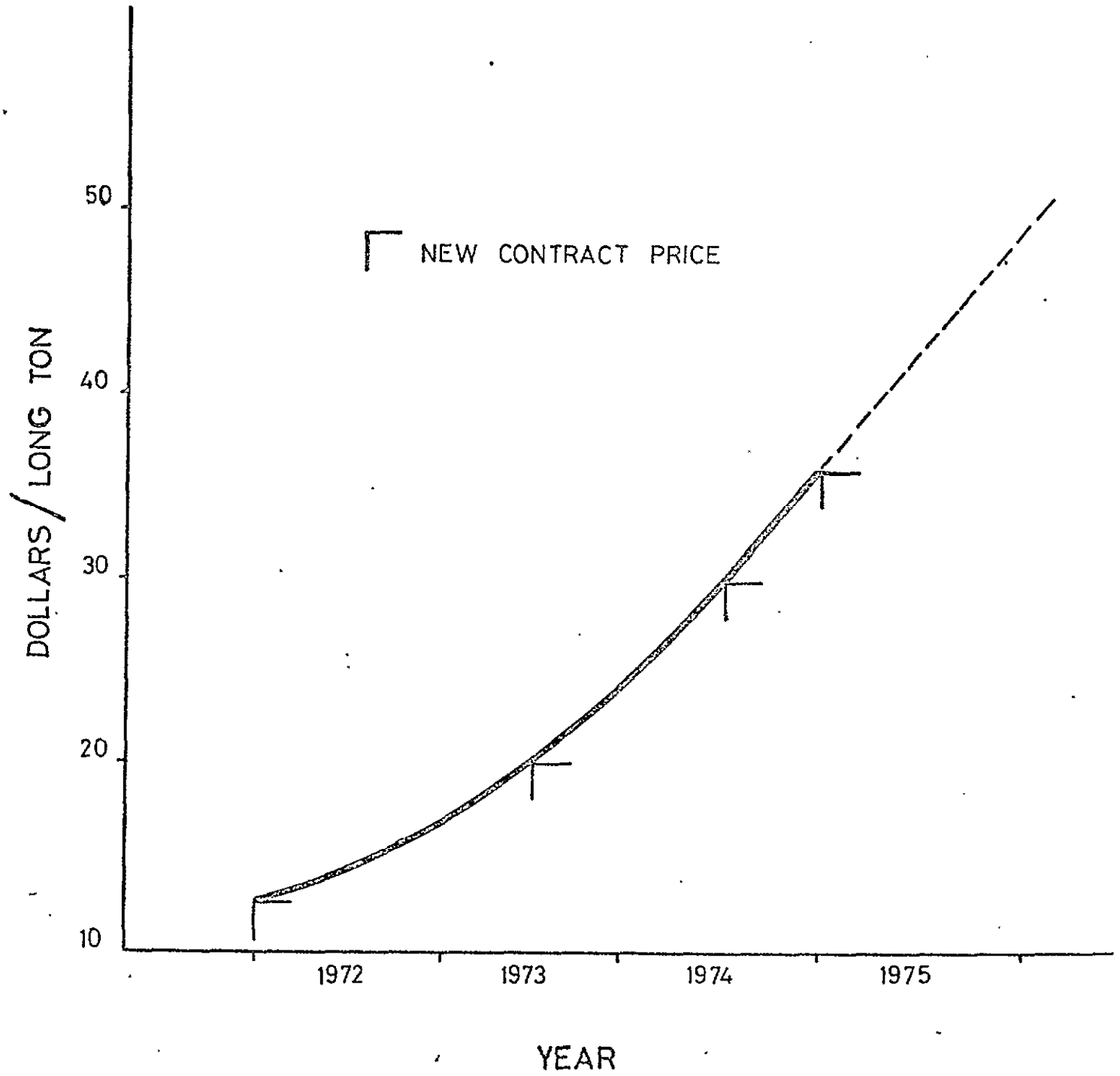


FIG. 6

3. HYDROCARBON AND BY-PRODUCT RESERVES

A. Oil: Production and Potential

The total reserve of proved crude oil in the province at the end of 1973 was estimated at 131,227,000 barrels. The annual crude production was 21,191,000 barrels. At this rate of production, the present proved reserve is sufficient for 6.2 years. In addition to the proved reserve, an estimated 153,171,000 barrels of probable reserves are projected, thus suggesting at present rate of consumption, these probable reserves might suffice for another 7 years.

Oil production in quantity began in 1961 and during 1961 and 1962 increased to a production rate of 12.5 million barrels per year. After a slight decline in 1964 the production rate increased steadily to slightly greater than 25 million barrels per year in 1969. This rate was maintained until 1971 at which time the production rate began to decline and has declined to about 21 million barrels per year in 1973.

All the crude oil found in the region to date has been discovered in the general area north of Fort St. John. Discoveries have been confined to an area some 60 miles wide and extending some 70 miles north of Fort St. John. No crude oil has been discovered in the Fort Nelson area or the Grizzly area to date. (See Figure 8)

The area in which the discoveries have been made has been drilled extensively and although a number of gas finds have been made, the probability of finding additional crude oil is low. In the Fort Nelson area the density of drilling is somewhat less, but the fact that no oil has been found to date, suggests that major discoveries of crude oil are unlikely. No discoveries have been made south of Fort St. John to date.

The discovery rate in terms of barrels of new oil reserves found per year has declined, resulting in a net decrease in the proven reserves of 16,576,000 barrels during the last year.

Production from the fields declined by 3,000,000 in 1973 and a similar decrease is forecast for 1974. As the pressure in the fields fall, a continuing decline in production is forecast.

There is little doubt that additional reserves will be found, but the probability of discovering major fields equivalent to the known reserves is extremely remote. It would appear that an optimistic forecast of the crude oil production for the region is of the order of 15 years and that the decline will have reached a critical proportion within 10 years.

B. Natural Gas

1. Natural Gas: Present Production

All of the existing natural gas fields in British Columbia are within the boundaries of British Columbia Census Division No. 23. These fields are situated in the sedimentary formation lying on the eastern flank of the Rocky Mountains, extending over an area beginning some 100 miles south of Fort St. John and trending in a northerly direction to the Yukon border. Two areas provide the major production capability, these being the fields adjacent to Fort St. John and the fields adjacent to Fort Nelson and east of Fort Nelson. The Beaver River field on the border of Yukon is also producing and the Grizzly field some 90 miles south of Fort St. John is being drilled. The established reserves are shown below as published by B.C. Department of Mines and Petroleum Resources:

	Raw Gas BSCF	Residue Gas BSCF	Residue Gas Basis 1000 BTU	Natural Gas Liquids MSTB	Sulphur MLT
Ultimate Recovery	13,776.8	12,046.4	12,437.1	172,058	5,355
Cumulative Production December 31, 1972	3,042.2	2,694.3	2,847.2	62,362	1,171
Reserves as of December 31, 1972	10,550.4	9,191.3	9,441.7	111,182	4,173
Revisions - 1973	+ 4.7	+ 1.0	- 17.6	-4,055	- 96
Drilling - 1973	+179.5	+159.8	+165.8	+2,569	+106
Production - 1973	-474.7	-423.2	-442.2	-5,823	-138
Reserves as of December 31, 1973	10,259.9	8,928.9	9,147.7	103,873	4,045

Notes: MSTB = Thousands of stock tank barrels, where one barrel contains 34.97 Imperial gallons.

BSCF = Billions of standard cubic feet at 14.65 psia and 60°F.

MLT = Thousands of long tons.

MMSCF = Million of standard cubic feet at 14.65 psia and 60°F

Fort St. John Natural Gas Fields

The Fort St. John area comprises some 60 gas fields of which approximately 75% are connected. The fields are multiphase and produce not only raw gas, but associated natural gas liquids including propane butane and pentanes plus, a major source of petrochemical feed stock. This area also contains the only producing oil fields in the province.

Approximately 1,000 miles of connecting gas lines of varying sizes and capacities transport the gas to the processing plant at Fort St. John where sulphur is removed. The plant is about twenty years old and is operating at full capacity. A major malfunction in this plant, particularly during the winter heating season, would create serious delivery problems. A second plant probably located in the Fort St. John area is being contemplated.

Fort Nelson Natural Gas Fields

The Fort Nelson fields are dry gas fields with no associated natural gas liquids. The gas contains little, if any, ethane and the product from these fields is not suitable for a petrochemical feed stock. The established reserves however do represent 42% of the presently known reserves of the Province. Approximately 25% of the fields are connected and the process plant is operating at 50% of capacity.

2. Natural Gas: Potential Production

The established reserves of natural gas are estimated at 9.1 trillion standard cubic feet. While there is little disagreement with this number, there is considerable disagreement concerning the potential reserves which may ultimately be found. The general consensus suggests the ultimate recovery will be two-to-two and one-half times the present established reserves or of the order of 21 trillion standard cubic feet.

The only known reserves of gas in British Columbia have been located in the geologically favourable area east of the Rocky Mountains extending from some 60 miles south of Dawson Creek to the Yukon border, a total of approximately 350 miles. The Geological Survey of Canada has outlined two additional areas where the geology may be favourable, these being the Fraser Plateau in south central British Columbia and the continential shelf. Based on the geological structures, numbers have been assigned as a best guess to the potential reserves of the province as shown below:

East of the Rocky Mountains	21.1 TSCF
Bowser Basin) Quesnel)	5.6
Offshore	3.6
Total Potential	30.3 TSCF

Drilling for oil and gas had its beginning in the early 1950's and increased from a modest 200,000 feet in 1955 to 1,600,000 feet in 1962. Since that time the drilling rate has declined to approximately 1,000,000 feet per year during the past ten years. This decline in exploration activity in British Columbia, as compared to Alberta, is in part due to the deeper formation and consequent higher costs existing in the province where wells are drilling to depths of 15,000 feet and may cost two to four million dollars.

The rate of finding is usually indicative of the potential of future discoveries. The discovery rate grew from approximately 250 BSCF per year in the early 1950's to over 400 BSCF per year in the period 1957 to 1961. During the period 1961-1968, the discovery rate dropped to 250 BSCF per year and has leveled off at approximately 150 BSCF per year. Historically this is the usual pattern and the discovery rate can be expected to decline.

The delivery rate of a gas field declines as the pressure of the field diminishes. The delivery rate is thus a function of the reserve and the pressure in the field. The delivery index is of the order of 6,500 cubic feet of reserve to sustain a delivery rate of one cubic foot of gas per day. Based on a reserve of 9.1 trillion cubic feet, the postulated delivery rate is 1.4 BSCF per day. This delivery rate will decline as the gas is produced unless supplemented by new finds.

The accompanying graph, Figure 9, represents the forecast daily deliverability of the field based on a finding rate of 150 BSCF per year and assuming the unconnected fields will be connected by 1980.

The projected British Columbia demand as forecast by Canadian Resourcecon Limited, for a period of 20 years, is shown with the superimposed demand of the El Paso export contract of 809 MMSCF per day. This contract terminates in 1989.

Figure 9 indicates the average daily demand can be met over the ensuing five years. The average daily demand however, is increased significantly during the winter heating period. During the winter of 1973-1974, the peak demand exceeded the supply on occasions by over 200,000,000 standard cubic feet. This condition will continue to exist and the peak short-fall will increase over the five year period as the provincial requirements increase.

Within five years the deliverability of the fields will begin to decline as the field pressure falls. During the period 1980 to 1988, the termination date of the export contract, the deliverability will show a deteriorating position with average daily short-falls reaching 700-800 MMSCF. This short-fall will be even greater during the peak demand period. With the termination of the export contract in 1988, the forecast requirements can be met although peak demands may exceed the supply. Unless other sources can be found to supplement the existing reserves, it is extremely doubtful if the provincial requirements can be met by 1995 or thereafter.

C. Natural Gas Liquids

The established reserves of natural gas liquids are estimated at 103,873,000 barrels at the end of 1973. These reserves comprise 48,993,000 barrels of propane, 26,900,000 barrels of butane and 27,978,000 barrels of pentane and heavier fractions, of which 80% is located in the Fort St. John area.

The production of natural gas liquids in 1973 amounted to 5,823,000 barrels, whereas the additions of the reserve from new sources was 2,569,000 barrels. The finding rate was 44% of the depletion rate. The addition of 2,569,000 barrels of natural gas liquids in 1973 represented an addition of 2.5% of the reserve, whereas the production in 1973 represented 5.6% of the reserve. As these liquids have mainly been found in the Fort St. John district, it is anticipated the finding rate will deteriorate and it is a reasonable assumption that reserves will be depleted in twenty years.

D. Sulphur

The total reserves of by-product sulphur are estimated at 4,045,000 long tons as of the end of 1973. A total of 138,000 long tons were sold during the year and additions to the reserve amounted to 106,000 long tons. The net reduction in the reserve was 32,000 long tons or less than 1%.

While the current demand for sulphur is reasonably good, the long term market outlook is not encouraging especially in the western part of North America. The potential production of sulphuric acid from existing and proposed non-ferrous metal smelters is well in excess of the ability of industry and fertilizer plants to absorb. Sulphuric acid production from proposed smelters in British Columbia would be in direct competition to and possibly better situated to supply the available market than acid made from sulphur in the Northeast. Whether or not Northeastern British Columbia sulphur will be moved or stockpiled over the next decade will depend on transportation cots to market in competition with smelter acid and Alberta sulphur.

The forecast food shortage in the world as population increases may well change the economics of the entire fertilizer industry. Ammonia and sulphuric acid are basic to the production of ammonium sulphate and ammonium phosphate fertilizer. The demand for sulphur can be expected to increase dramatically over the next twenty year period.

E. Oil and Gas Reserves: Social Implications

The projected depletion of the oil and natural gas reserves of the province poses some serious problems which require immediate attention by governing bodies in British Columbia. The provincial policy objectives are unchanged, these are - (1) to assure that British Columbia natural gas requirements are met and (2) to ensure that the export price paid for natural gas is just and reasonable.

It is obvious that the gas reserves of the province have been over-committed over the long term. Serious shortfalls were manifest during the peak day requirements in the winter of 1973-1974 and these deficiencies have caused severe disruption of energy supply patterns in both British Columbia and the United States Pacific Northwest and will continue to do so. These shortfalls are receiving vigorous attention and the British Columbia Petroleum Corporation and Westcoast are bringing on unconnected reserves and eliminating plant bottlenecks as rapidly as possible. Over the next five year period, the addition of the unconnected reserves is expected to maintain the average daily requirement, although maximum peak day requirements will not be met.

During the period 1980 through 1988 serious gas supply deficiencies are forecast if the export contract is to be honoured. In the latter years of the export contract, the ability to deliver may fall short of the demand by as much as 30%. This shortfall will obviously impose severe restraints on the growth potential of the province.

The termination of the export contract in 1989 will provide some relief to the serious shortfalls in preceding years but the projected material growth rate of province will be sufficient to tax the then existing reserves to the limit.

In summary, under existing and forecast demands the supply of gas is reasonably assured during the next five years. Serious shortfalls will develop over the remaining life of the export contract. On the termination of the contract, the reserves will be depleted to the point where little growth potential will remain for B.C. Industry.

The projected decline of the oil and gas reserves of the province poses serious social and economic problems. Approximately 23 percent of the gas demand in the province is used for heating homes and apartments, 13 percent for commercial, 17 percent industrial, 17 percent forest industry, 15 percent thermal and 15 percent is used in compressors and other transmission losses. As oil reserves are projected to decline, little would be gained by conversion from gas to oil. An examination of the users indicate only the forest industry has an alternate supply of extraneous energy in the form of hog fuel.

F. Oil and Gas Policy Options

The impending shortage of the petrochemical reserves of the province over the next decade and critical depletion of these reserves within two decades requires vigorous action by government. The lead time for substition of these energy resources requires a lead time of five to ten years and in many cases the technology is not resolved at this point in time.

Some hard decisions must be made by government with respect to the export contract. If the contract is to be honoured, there would appear to be little potential for growth of commercial and industrial use of the resource within the province. On the other hand, the forecast demand is expected to more than double during the life of the contract. The total demand cannot be delivered unless supplemented by reserves from the Arctic. No decision has been made on transmission lines but present estimates suggest that a lead time of six years will be required to tap these reserves. Petroleum resources of Alberta cannot be contemplated as a source of supply for British Columbia. The supply situation in Alberta, although on a grander scale, parallels the British Columbia situation and that province faces similar decisions.

Certain short term and long range alternatives are available to supplement the forecast depletion of British Columbia's reserves. These options are:

1. Governmental assistance in the form of tax incentives to encourage exploration activity to develop the full potential of the fields.

2. The discovery rate of oil in the Arctic has been low but recent finds in the Beaufort Sea have been encouraging. A considerable amount of proven gas reserves are available and estimated at 6.1 trillion SCF. The potential reserves are estimated at 120 trillion SCF. British Columbia should consider how to tap into these supplies.

3. The Northeast Region of the province contains large deposits of coal. Much of this is high grade metallurgical coal which will be required for steelmaking in the future. As a by-product of this industry, amounts of oxidized coal and coal rejects will become available for thermal use or coal gasification. A number of processes are in the pilot plant stage to convert coal to methane which would directly supplement the diminishing reserves of natural gas. The advantages of coal gasification in the Northeast is that a gasification plant would have easy access to established transmission pipelines. However, it is probably more logical to have a coal gasification industry built around the large, low value Hat Creek coal deposit. Generally the major amounts of coal existing in the Northeast are too high quality to consider using all but a small fraction for gasification.

G. Petrochemical Industry

Under existing conditions the present reserves of oil and gas are sufficient to sustain a petrochemical industry for the greater part of the year. The peak demand during the winter months might seriously curtail operations. Pending the resolution of the problems involved in the export of petroleum products, it does not appear feasible to establish a petrochemical plant in this sector. The economics of transporting the raw product in its natural state as compared to transporting the fractions separately will favour establishing a petrochemical plant as close as possible to the final market for the end product.

H. Oil and Gas: Impact on Northeast Region

1. Exploration

During 1973 some 53 individual drilling rigs were active in British Columbia. A total of 874,753 feet of drilling was accomplished of which almost all was done in the Northeast Sector of the province. Drill footage declined 24% as compared to 1972. The contributing factors were lack of hydrocarbon discoveries in the area and a general orientation of exploration funds to other areas, notably northern Canada. The more favourable economic climate in the United States is also tending to encourage drilling crews to work across the border. Some encouragement in the form of tax concessions will be required if the full potential of the area is to be developed. Currently a drilling rig is guaranteed $2,000 a day retainer in British Columbia compared to $2,700 a day for the same rig in the United States. Exploration activities will employ approximately 1,000 men if the exploration programme is to continue at the present rate.

2. Pipeline Activity

Approximately 75% of the oil and gas fields in the Fort St. John area are connected by pipelines, whereas a number of outlying fields in the Fort Nelson remain to be serviced by pipeline. The Grizzly field some 100 miles south of Fort St. John is not connected by pipeline. The potential of the Grizzly field and the quality of gas has not been established and no final decision has been made as to where it might be transported.

Two choices appear open, a pipeline to the west to connect to No. 4 compressor station at Prince George or northward to connect to No. 2 compressor station at Willow Flats. This line is expected to be connected in 3 to 4 years. It is expected that 400-500 men will be engaged in extending pipelines over the next five years.

3. Plants

Two gas plants are in operation in the region. The Fort St. John Plant is located at the town of Taylor and has a capacity of 450 million cubic feet per day and is operating at full capacity. Associated with this plant is an oil refinery operated by Pacific Petroleum Limited with a capacity of 2,000 barrels of crude per day. The Fort Nelson Plant has a capacity of 1.1 billion cubic feet per day but is not operating at capacity.

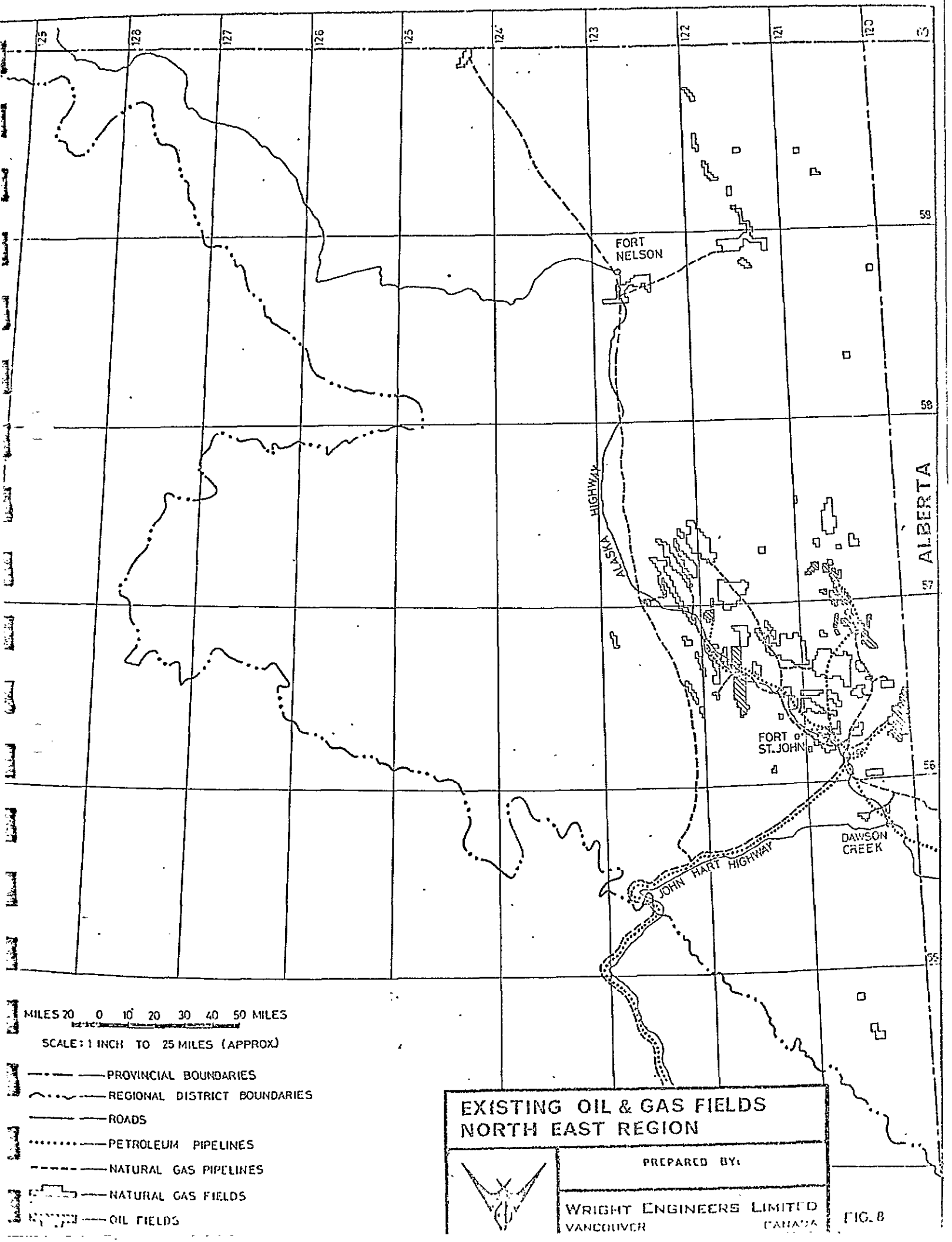
A new plant is under consideration but final planning has been delayed until the full potential of the Grizzly field can be assessed. The location of the plant and the size of the plant has still to be determined. The capital cost of this plant cannot be estimated at this time but is of the order of one hundred dollars per thousand cubic feet per day. A plant equivalent to the Fort Nelson plant is expected to cost over $100 million. It is expected that this plant will be built within five years. An estimated 500 men would be engaged in plant construction for a period of two years.

4. Employment

The oil and gas industry is not a labour intensive industry. The Fort St. John plant employes approximately 75 men while 110 men are employed at the Fort Nelson plant. Over the ensuing five year period, 1,000 men may be directly engaged in exploration activities and 400-500 men involved in extending pipelines.

Plant construction is expected to employ an additional 500 men for a period of two years during the period. Total employment may peak at 2,000 during the period.

Over the 20 year period, it is expected that the area will be fully developed in the first five years and that exploration and construction activities will decline and stabilize at about 300 men directly employed by the industry.


129
128
127
126
125
124
123
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121
120
59
58
57
56
55
FORT NELSON
ALASKA HIGHWAY
ALBERTA
FORT ST. JOHN
DAWSON CREEK
JOHN HART HIGHWAY
MILES 20 0 10 20 30 40 50 MILES
SCALE: 1 INCH TO 25 MILES (APPROX)
PROVINCIAL BOUNDARIES
REGIONAL DISTRICT BOUNDARIES
ROADS
PETROLEUM PIPELINES
NATURAL GAS PIPELINES
NATURAL GAS FIELDS
OIL FIELDS
EXISTING OIL & GAS FIELDS
NORTH EAST REGION
PREPARED BY:
WRIGHT ENGINEERS LIMITED
VANCOUVER CANADA
FIG. 8

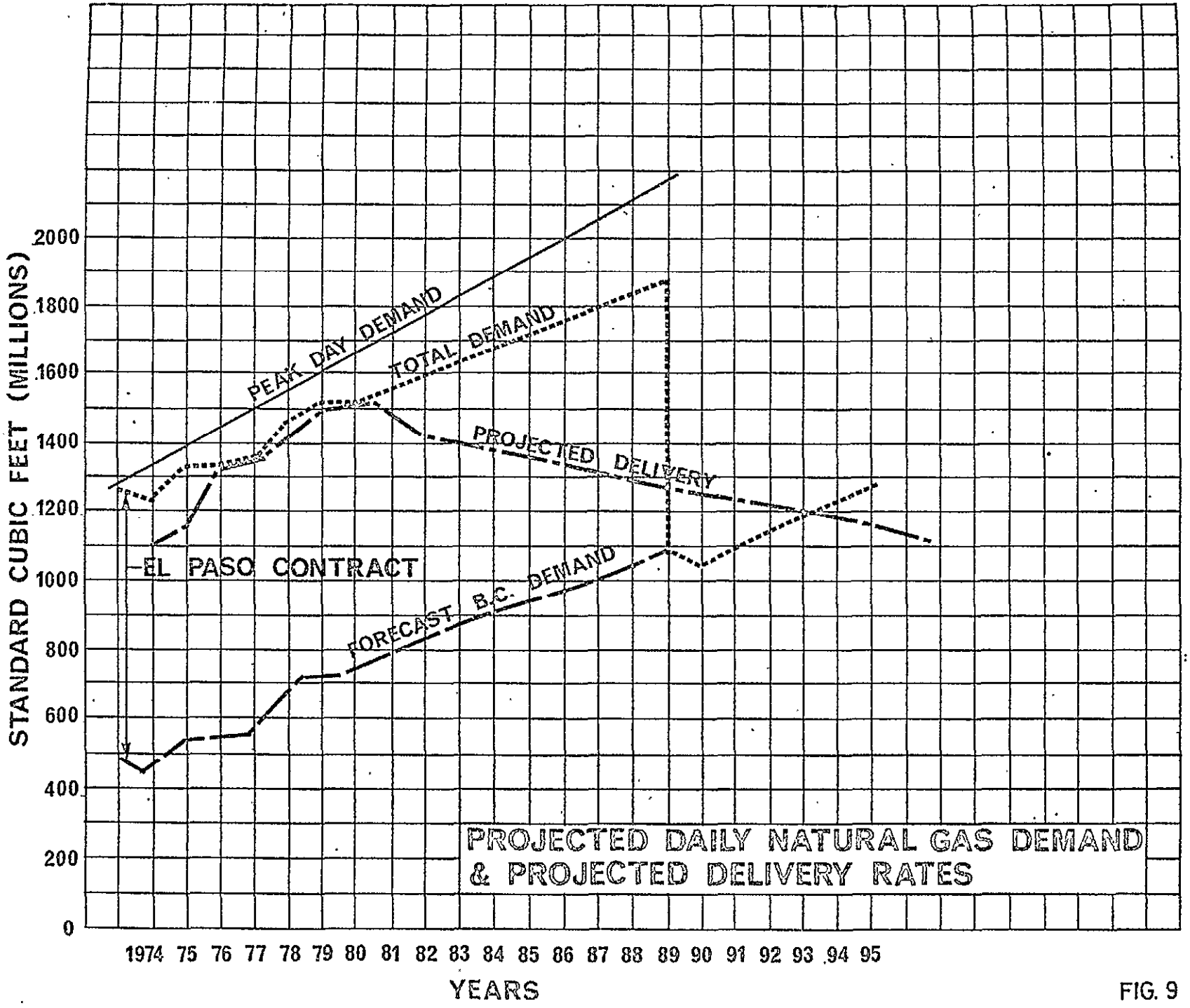
STANDARD CUBIC FEET (MILLIONS)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
PEAK DAY DEMAND
TOTAL DEMAND
PROJECTED DELIVERY
EL PASO CONTRACT
FORECAST B.C. DEMAND
PROJECTED DAILY NATURAL GAS DEMAND
& PROJECTED DELIVERY RATES
1974 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95
YEARS

FIG. 9

APPENDIX A

ESTIMATED OPERATING COSTS AND EARNINGS OF EXISTING AND POTENTIAL MINES IN THE NORTHEAST REGION

TABLE 1

ALL PROJECTS - STATEMENT OF OPERATING COST ESTIMATES

(Per Ton Ore)

Project	Davis-Keays Mine & Mill	Davis-Keays Mine Only	Robb Lake Mine & Mill	Silver Standard Quarry & Si° Plant	Consolid. Churchill Mine & Mill	Liard Fluorspar Mine & Mill
Mining	$ 10.00	$ 10.00	$ 9.00	$ 2.50	$ 9.00	$ 4.00
Crushing				0.25		
Ore Transportation		0.80		8.00		9.25
Silica to Furnace				$ 11.00		
Milling	2.60		3.20		2.60	2.50
Smelting Furnace Costs:						
Green Petroleum Coke	($ 50.00 /ton delivered)			$ 18.00		
Metallurgical Coal	($ 50.00 /ton delivered)			5.00		
Hog Fuel	($ 10.00 /ton delivered)			8.00		
Electrodes	($200.00 /ton delivered)			11.00		
Power	(10 mils/kwh)			41.00		
Labour	($5,000 /year/man)			35.00		
Total Smelting Costs				$ 118.00		
Maintenance	2.50	1.00	2.75	1.11	2.50	2.50
Administration	1.50	1.50	1.50	0.48	1.50	1.50
Housing	0.50	0.50	0.50	0.48	0.50	0.50
Transportation - Supplies	3.00	3.00	2.00	0.63	3.00	3.00
Total Direct Cost	20.10	16.80	18.95		19.10	23.25
Total Indirect Cost	0.50	0.50	0.50		0.50	0.50
TOTAL OPERATING COST	20.60	17.30	19.45	129.00	19.60	23.75

TABLE 2

CONSOLIDATED CHURCHILL COPPER
STATEMENT OF ESTIMATED EARNINGS

		(Per Ton Ore)
Gross Revenue (62¢/lb. copper)		$ 34.00
Less: Allowable Costs -		
Smelting and Refining	$ 8.00	
Transportation	6.00	
(Concentrate)		(14.00)
Net Value		20.00
Basic Royalty, 5% of "Net Value"		(1.00)
Net Value Less Basic Royalty		19.00
Operating Cost (Per Table 1)		(20.00)
Operating Profit	$/ton	(-1)
	$/year	(300,000)

TABLE 3

QUICK CAPITAL COST ESTIMATE FOR HYPOTHETICAL DAVIS-KEAYS MINE AND MINE AND MILL COMBINATION

(WRIGHT ENGINEERS LIMITED QUICK CAPITAL COST ESTIMATE)

	Mine and Mill	Mine Only
Mining and Exploration	$ 10,354,000	$ 10,354,000
Crushing and Screening	1,620,000	
Concentrating	2,257,000	
Water Supply	527,000	
Tailing Disposal	640,000	
Power Supply, Sub-Station and Distribution System	1,270,000	
Access Road, Surface Vehicles and Fuel Storage	1,849,000	1,849,000
Ancillary Buildings	783,000	783,000
Employee Housing	7,056,000	5,000,000
Working Capital	2,135,000	1,000,000
Engineering and Construction Management	2,372,000	500,000
Administration Costs	609,000	400,000
Interest Charges	2,001,000	1,320,000
TOTAL CAPITAL COST	33,679,000	21,206,000

TABLE 4

DAVIS KEAYS - SEPARATE MILL
STATEMENT OF ESTIMATED EARNINGS

		(Per Ton Ore)
Gross Revenue (62¢/lb. copper)		$ 36.00
Less: Allowable Costs -		
Smelting and Refining	$ 8.00	
Transportation (Concentrate)	6.00	(14.00)
Net Value		22.00
Basic Royalty, 5% of "Net Value		(1.00)
Net Value less Royalty		21.00
Operating Cost (Per Table 1)		(21.00)
Capital Cost Write-off (net of any interest)		(24.00)
LOSS		(24.00)

TABLE 5

DAVIS KEAYS - MILLING AT CHURCHILL
STATEMENT OF ESTIMATED EARNINGS

		(Per Ton Ore)
Gross Revenue (62¢/lb. copper)		$ 36.00
Less: Allowable Costs -		
Smelting and Refining	$ 8.00	
Transportation (Concentrate)	6.00	(14.00)
Net Value		22.00
Basic Royalty, 5% of "Net Value		(1.00)
Operating Cost (Per Table 1)		(17.00)
Operating Profit before taxes	$/ton	-
	$/year	-

( ) Denotes Negative

TABLE 6

QUICK CAPITAL COST ESTIMATE FOR HYPOTHETICAL ROBB LAKE MINE AND MILL

(WRIGHT ENGINEERS LIMITED QUICK CAPITAL COST ESTIMATE)

	Mine and Mill
Mining and Exploration	$ 9,545,000
Crushing and Screening	1,651,000
Concentrating	2,662,000
Water Supply	537,000
Tailing Disposal	665,000
Power Supply, Sub-Station and Distribution System	2,256,000
Access Road, Surface Vehicles and Fuel Storage	9,109,000
Ancillary Buildings	800,000
Employee Housing	7,125,000
Working Capital	2,783,000
Engineering and Construction Management	3,091,000
Administration Costs	820,000
Interest Charges	2,593,000
TOTAL CAPITAL COSTS	43,637,000

TABLE 7

ROBB LAKE
STATEMENT OF ESTIMATED EARNINGS

		(Per Ton Ore)
Gross Revenue (zinc 35¢/lb. lead 23¢/lb.)		$ 28.00
Less: Allowable Costs		
Smelting and Refining	$18.00	
Transportation (Concentrate)	3.00	(21.00)
Net Value		7.00
Basic Royalty, 5% of "Net Value"		(0.00)
Net Value Less Royalty		7.00
Operating Cost (Per Table 1)		(19.00)
Operating Profit before taxes	$/ton	(12.00)
	$/year	(4,400,000)

TABLE 8

LIARD FLUORSPAR MINING LTD.
STATEMENT OF ESTIMATED EARNINGS

		(Per Ton Ore)
Gross Revenue		$ 19.00
Costs: Operating Cost (Per Table 1)	$24.00	
Transportation (Concentrate)	12.00	(36.00)
Operating Profit	$/ton	(17.00)
	$/year	(6,200,000)

TABLE 9

SILVER STANDARD SILICON PLANT
STATEMENT OF ESTIMATED EARNINGS

			(Per Ton Ore)
Gross Revenue			$ 370.00
Costs:	Mining and Smelting (Per Table 1)	$135.00	
	Transportation (Silicon Metal	6.00	
	U.S. Import Duty	13.00	
			$(154.00)
Operating Profit before taxes		$/ton	216.00
		$/year	13,000,000

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PERSONS INTERVIEWED AS PART OF RESEARCH FOR THIS REPORT

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J. A. Kavanah	Manager of Engineering, Westcoast Transmission Company Limited
J. Newell	Exploration Geologist, Texas Gulf, Inc.
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J. Rhodes	Chairman, British Columbia Petroleum Corporation
M. M. Rich, P.Eng.	Senior Gas Supply Planning Engineer, B. C. Hydro
A. Ritchie	President, Silver Standard Mines Ltd.
E. Scholz	President, B. C. & Yukon Chamber of Mines
F. Whiting	Exploration Geologist, Brascan Resources Ltd.

BR - GENERAL INFORMATION
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BRAMEDA RESOURCES LTD.

E V A L U A T I O N

April, 1976

Casino Property

(100% owned by Casino Silver Mines, Ltd.)

Reserve Estimates, 1970

Estimated By	Tons	% Copper	% Molybdenite	Gross Value Per Ton*
Brameda- Initial Pit	170,000,000	0.37	0.039	$ 8.62
Metallgessellschaft (C. Knight, Consultant)	427,933,000	0.267	0.0369	6.50
Archer,Cathro and Associates	209,420,000	0.353	0,047	8.54
Chapman,Wood and Griswold	431,995,000	0.274	0.037	6.64

* Copper @ $1.00 per lb. and Mo @ $2.62 per Lb.

Using the same metal values, a comparison with operating mines in British Columbia can be made as follows:

Operation	Reserves (Approximate)	% Copper	% MoS_2	Gross Value/Ton
Brenda Mines, Ltd.	150,000,000	0.180	0.080	$ 6.11
Gibraltar Mines,Ltd.	347,000,000	0.371	0.016*	7.92
Lornex Mines, Ltd.	293,000,000	0.427	0.014*	8.98

* MoS_2 not regularly recovered.

Although it is the considered opinion that Casino will eventually be a major producer, the timing of production, retained equity and amount of earnings flowing to Brameda are at present a matter of speculation. Nevertheless, these could be substantial in 5 to 10 years' time.

COAL

Brameda holds 122 coal licences in an area from 20 to 50 miles south of Chetwynd, British Columbia. As shown on the map, these are divided into five groups, with exploration and development on three of them currently being financed by other companies under farmout arrangements.

SUKUNKA GROUP

This property covers Brameda's original coal discovery and most of the exploration and development work since then has been concentrated on it. As indicated earlier, Brameda did over 40,000 feet of diamond drilling and began underground testing in 1970. Since then additional work has brought the totals to 130,400 feet (25 miles) of drilling and 16,000 feet of underground work.

Most of the work has been in the Chamberlain and Skeeter seams. Both contain low to medium-volatile coal with low ash and sulphur content and excellent coking and blending qualities. The following table shows predicted average coal specifications following heavy media separation and froth flotation, based upon results of metallurgical tests on both cores and bulk samples.

	Chamberlain Seam	Skeeter Seam
Ash	4.1%	4.5%
Volatile matter	22.5%	22.7%
Fixed carbon	72.4%	71.8%
Sulphur	0.49%	0.50%
FSI	8.5	8.5
Calorific value (Btu)	14,600	14,600

Reserves have been calculated as 120,000,000 long tons in place, with the majority of this being in the Chamberlain Seam. All of this is contained on 7 of the 41 Sukunka licences, where the programme for the last five years has been concentrated.

Most of this coal occurs in seams 6 to 10 feet thick, generally flat-lying, with dips in the range of 0 to 10 degrees. Mining would be by room and pillar and longwall methods, although work completed during the past year indicated several million tons of coal that may be amenable to open pit mining.

The property has been under option to Brascan Resources Ltd. and an affiliate since 1971. During the initial option period to September 1972 Brascan did sufficient work to earn a 7.5% interest in the property and purchased an additional 5% interest. The option has been extended several times, with minor alterations to the agreement.

Under the amended agreement which expires June 30, 1976, Brascan may commit to finance the property into production and, if so, may purchase an additional 47.5% interest to bring its total ownership to 60%.

BULLMOOSE GROUP

This property consists of 19 licences south of the Sukunka Group. It is under option to Teck Corporation, which has financed all of the exploration work to date and may earn a 50% interest after the expenditure of $1,000,000.

Exploration in 1972 and 1975, following return of the licences, consisted of geological mapping, trenching and 20,500 feet of diamond drilling. Drill-indicated reserves for the Chamberlain Seam are currently estimated at 60,000,000 tons in place. The coal quality appears to be similar to that on the Sukunka property, but with a more variable ash content. Additional work will be required including bulk sampling and metallurgical testing before estimates of saleable clean coal reserves can be made.

In addition to the Chamberlain Seam, at least an equal tonnage potential has been indicated in the Bird Seam. This has good coking characteristics but contains about 2% sulphur.

Recent studies of the Gates Seams, above the Chamberlain and Bird, have indicated the possibility of significant amounts of near-surface coking coal which may be mineable by open pit methods. Work next field season will be concentrated in this area.

MOUNT SPIEKER GROUP

During the year arrangements were concluded with Nichimen Resources Ltd., a Japanese company, to carry out exploration work on 28 licences in the Mount Spieker area. Nichimen has an option to place this property into production under terms which, if exercised, would leave Brameda with a 30% equity.

During 1975 additional geological mapping and 2,900 feet of drilling were carried out. Indications are that significant coal reserves will be developed on this property as well, and further work will be done in the coming field season.

CHAMBERLAIN GROUP

The 6 Chamberlain licences are being explored as a 50:50 joint venture between Brameda and Teck Corporation.

Geological mapping and trenching were carried out last year on a zone of coal seams which correlates in part with the Skeeter and Chamberlain horizons. A portion of this area may be mineable using open pit methods, and exploration will be continued in 1976.

BURNT RIVER GROUP

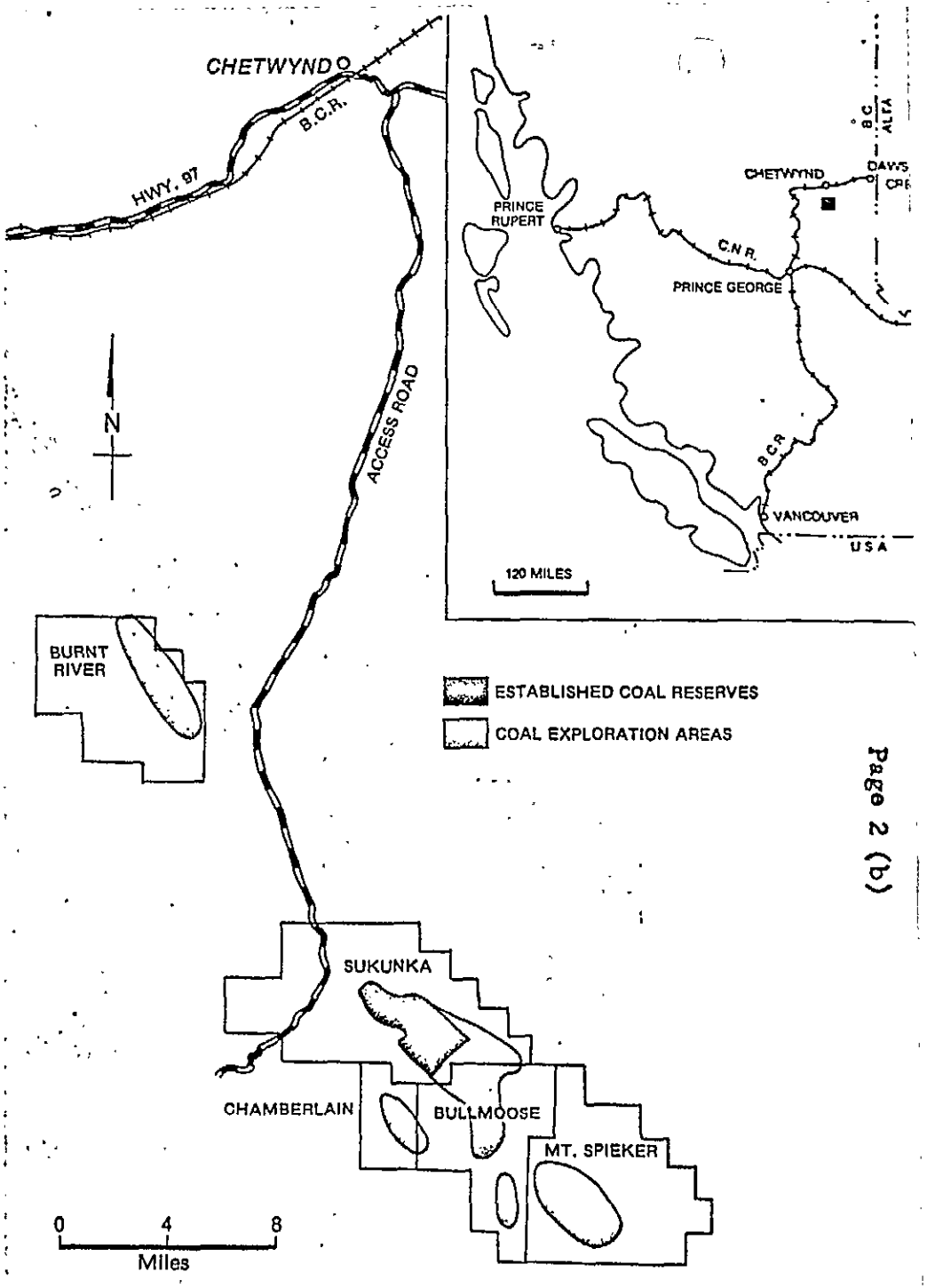
This 28 licence property is wholly-owned by Brameda.

Geological mapping during 1975 located several coal seams from 10-14 feet thick in areas of complex structure. Further work is planned for the next two years to evaluate both the reserve potential and possible mining methods.

CONSOLIDATED CHURCHILL COPPER

The Churchill copper mine, which had been closed since October 1971, was re-opened in January 1974. Kam-Kotia Mines Ltd. provided the required new capital and was entitled to recover this out of first profits, if any, after which proceeds were to have been split.

The mine closed again in March 1975. During 15 months it produced 13,973,000 pounds of copper. The operating profit, before depreciation and amortization of re-opening costs, was $93,000. Royalties payable under the Mineral Royalties Act were $213,000 placing the mine into an operating loss position.



BRAMEDA RESOURCES LTD.

Estimate of Potential for Sukunka Coal Properties

GROUP	STATUS	GEOLOGICAL RESERVES	RECOVERABLE ESTIMATE	REMARKS
Sukunka	Brascan Option as to 60%	120,000,000 Proven	70,000,000 2,000,000	Underground Surface
Bullmoose	Teck Option as to 50%	Indicated 60,000,000	36,000,000	Underground
Chamberlain	50:50 Jointly with Teck Corp.	40,000,000 Guessed	20,000,000 Guessed	Surface in part.
Mt. Spieker	Nichimen Option as to 70%	100,000,000 Guessed	70,000,000 Guessed	Probably surface mining
Burnt River	100% Brameda	50,000,000 Guessed	40,000,000 Guessed	Probably surface mining.
			238,000,000	

At 6 million tons per annum = 40 years production.

Earnings Summary:

The Cash Flow Projection from the Brascan - Sukunka coal operation alone shows what is considered to be a conservative estimate of earnings of $1.00 per share to Brameda within 5 years, rising to $1.70 per share for the balance of the life of the mine (30 years).

Earnings from other sources, though speculative at this time, are still considered to be very realistic and conservative expectations, viz.,

Source	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Brascan	.10	.37	.95	1.00	1.70	1.70	1.70	1.70	1.70	1.70
Bullmoose			.10	.20	.30	.40	1.00	1.00	1.00	1.00
Chamberlain			.10	.20	.30	.40	.60	.60	.60	.60
Other Coal			.10	.20	.30	.40	1.00	1.00	1.00	1.00
Casino					.20	.20	.50	.50	.50	1.00
Totals	.10	.37	1.25	1.05	2.10	3.10	4.80	4.80	4.80	5.30

Present Value (1976) - Brameda Shares-

Share of Earnings from Brascan Operation only from first 10 years' production. Discounted at 15% per annum to 1976.

	Present Value Total Earnings	Present Value Earnings/Share
If Year 1 is 1977	$ 38,397,500.	$ 3.92
If Year 1 is 1978	$ 33,405,750.	$ 3.41
If Year 1 is 1979	$ 29,037,600.	$ 2.96

Note:

During the past 15 months, the writer has invested nearly all of his surplus funds (not a staggering amount) in the shares of Brameda Resources,Ltd.

.....

Vancouver, B.C.
April 2, 1976.

Brameda Resources, Ltd.

PROJECTED CASH FLOW

From Brascan - Sukunka Operation

Assumptions:

1. Capital Requirements:*

i) Exploration and Pre-Production Expense (Including accrued Interest)		$ 20,000,000.	
ii) Construction -	Year 1	60,000,000.	
iii) Expansion -	Years 2-3	50,000,000.	$130,000,000.
iv) Replacements -	Years 4-5		30,000,000.
		Total	$160,000,000.

* Rail and Power Line financed by Province, amortized as operating expense.

2. Loans (12% Interest)

i) Through Year 1 — $ 80,000,000.
Remainder of Capital Costs recoverd from Earnings.

ii) Retired in 4-5 years.

3. Production:

Selling Price @ $60.00 per Long Ton, F.O.B. Port
Royalty: $1.50 per Long Ton.

	Year 1	Year 2	Years 3-10
Tons per Annum	600,000	1,500,000	2,000,000
Operating Cost/Ton	$30.00*	$22.00	$17.00

(*Partial Truck Haulage)

4. Depreciation:

i) Exploration and Pre-Production Expense, 100% Depreciable
ii) Other Capital Costs, 70% Depreciable.
iii) Write-offs at maximum rate.

5. Taxes: After Royalty, average 50% Taxable Income

6. Brameda : Share of Profits Calculation:

i) Return of "Initial Investment" ($130,000,000) .4x.2 x Gross Cash Flow
ii) Thereafter, 40% Net Cash Flow

Brameda Resources, Ltd.
Brascan – Sukunka Operation

CASH FLOW PROJECTION

April, 1976

(x 1,000)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Tons Shipped	600	1,500	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Gross Revenue	36,000	90,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
Royalty	750	2,250	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Net Sales	35,250	87,250	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000
Operating Cost	18,000	33,000	34,000	34,000	34,000	34,000	34,000	34,000	34,000	34,000
Operating Profit	17,250	54,250	83,000	83,000	83,000	83,000	83,000	83,000	83,000	83,000
Interest	6,000	8,880	7,680	4,080	480	-	-	-	-	-
NET before Depreciation	11,250	45,370	75,320	78,920	82,520	83,000	83,000	83,000	83,000	83,000
Depreciation	11,250	45,370	40,380	7,000	14,000	-	-	-	-	-
TAXABLE INCOME	Nil	Nil	34,940	71,920	68,520	83,000	83,000	83,000	83,000	83,000
Corporation TAX	Nil	Nil	17,470	35,960	34,260	41,500	41,500	41,500	41,500	41,500
NET PROFIT	Nil	Nil	17,470	35,960	34,260	41,500	41,500	41,500	41,500	41,500
Add: Depreciation	11,250	45,370	40,380	7,000	14,000	-	-	-	-	-
GROSS CASH FLOW	11,250	45,370	57,850	42,960	48,260	41,500	41,500	41,500	41,500	41,500
LESS: Capital Additions	-	30,000	20,000	10,000	20,000	-	-	-	-	-
Loan Payments	6,000	10,000	30,000	30,000	4,000	-	-	-	-	-
Property Payments	-	-	4,750	-	-	-	-	-	-	-
NET CASH FLOW	5,250	5,370	3,100	2,960	24,260	41,500	41,500	41,500	41,500	41,500
Cumulative N.C.F.	5,250	10,620	13,720	16,680	40,940	82,440	123,940	165,440	206,940	248,440
Loan Balance	74,000	64,000	34,000	4,000	-	-	-	-	-	-
Investment Bal. 80,000	71,000	64,710	38,890	4,520	(34,088)					
Brameda:										
Property Payment ($2)			4,750							
40% x 20% of G.C.F.	900	3,630	4,630	3,435						
40% Net Cash Flow					9,704	16,600	16,600	16,600	16,600	16,600
Total	900	3,630	9,380	3,435	9,704	16,600	16,600	16,600	16,600	16,600
Earnings per Share	$0.09	$0.37	$0.96	$0.35	$0.99	$1.70	$1.70	$1.70	$1.70	$1.70